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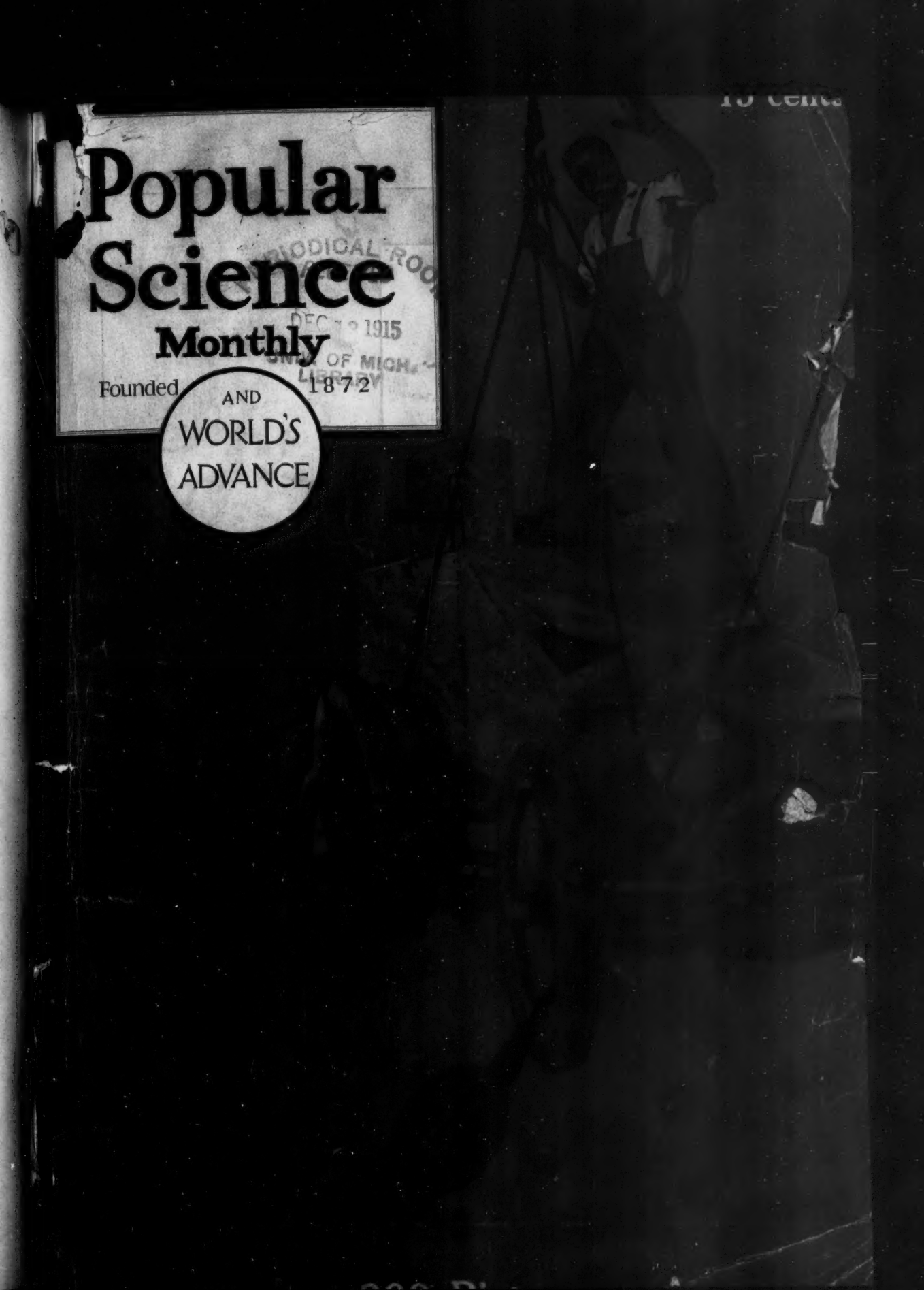

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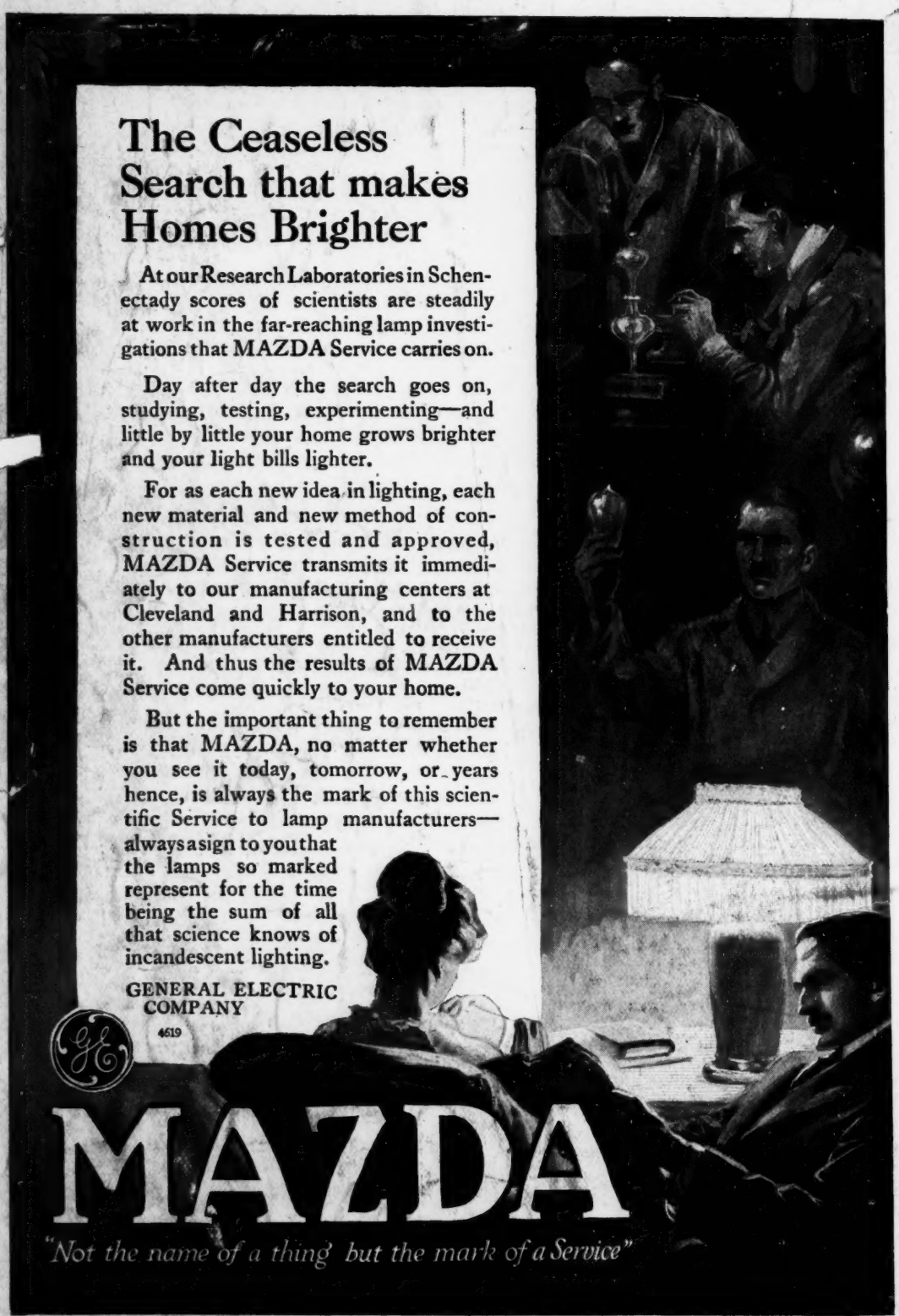

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WHAT A SLIDE MEANS AT PANAMA

(c) Underwood & Underwood, N. Y.

It will take months before the Panama Canal is opened to traffic again, as anyone will believe who contemplates this picture. Not only is the fairway clogged by slides, but also by mud, which is forced up from the bottom because of the pressure of the mountainous masses on either side of the Canal

POPULAR SCIENCE MONTHLY
AND
WORLD'S ADVANCE

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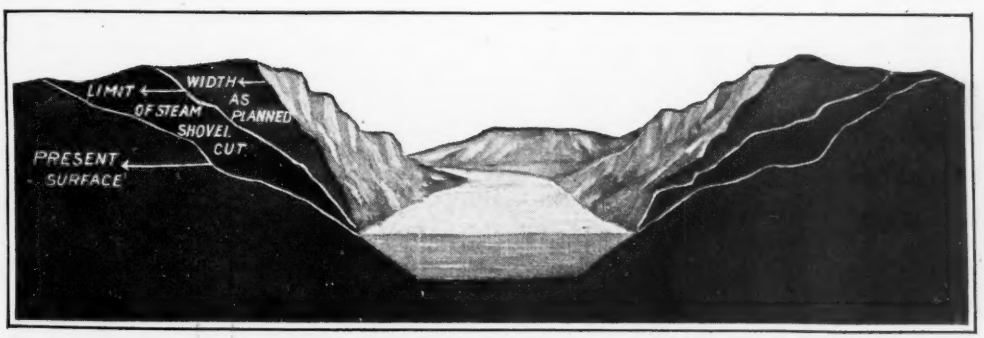
Why the Slides Slide at Panama

By J. F. Springer

WHILE the Panama Canal is by no means the longest in the world—the Suez Canal is twice as long—still the problems met and solved in its construction make it one of the truly greatest engineering undertakings of the world. And yet, the conquest of the natural conditions is not quite complete. The slides in Culebra Cut are not only a continual menace to the continuity of operation, but, as the present situation proves, they may easily interrupt traffic for months.

The canal pierces the continental ridge, at Panama only a few hundred feet in height and nine or ten miles in width. A V-shaped cut was made through this ridge and the canal located at the bottom of the V. It will be seen at once that there must be high slopes to either side. The slides occur because a mass on a slope loses its frictional grip on the underlying material, and slips — not necessarily with rapidity—on and down under the influence of gravitation. But "on and down" bring it at last into the canal itself. It may confidently be expected that in the course of time everything will have slipped and slid that is going to slip and slide; so that eventually the trouble will cure itself. No doubt the engineers put some dependance upon this consideration. If the slides could be counted upon to be moderate in their individual attempts and to allow proper intervals between, then we might be content to await a condition of final equilibrium. But the canal was built for strategic and commercial purposes, neither of which can wait on so slow a process. And so General Goethals has resumed his control.

The Panama Canal, unlike that of Suez, is not a sea-level waterway. The main portion of the canal, from Gatun



The canal was cut through a mountain in the form of a "V." Parts of the "V" have been steadily slipping down because they were located upon an underlying toboggan surface of firmer material, so it is thought. The illustration shows how the "V" has gradually widened since the first cut was made

Locks in the north to Pedro Miguel Lock in the south, has its normal surface eighty-five feet above the sea level on the Atlantic side. This means that the bottom is some eighty-five feet higher than would be the case if the water simply flowed through from ocean to ocean. The canal was elevated to secure the advantage of not having to cut the V down to the low level necessary for a sea-level canal. Carrying the point of the V down to a level eighty or eighty-five feet lower would mean vast additional excavation on the sides of the V. So the canal was constructed on a high level.

The most notable of the slides is known as the Cucaracha. It is at least thirty years old, and began its activities long before the Americans took charge, during a long period of inactivity extending from 1889 to 1905, a period when but little was done in the way of excavation. The motion is frequently slow, amounting to no more than a few inches per hour. It probably moves more or less in all seasons.

But Cucaracha is by no means the only slide. In one year as many as thirteen slides were in movement in the region of Culebra Cut. Slides occur at all seasons of the year. The precise cause of a slide does not seem to be known with certainty. It is probable that some slides may be safely attributed to the slow tobogganing of soft surface material on hard, underlying rock sloping toward the canal. The cutting away of material on the lower edge may easily precipitate a general movement of the material above simply because a support has been removed.

The slides have other effects besides that of moving down into the canal. One night in March, 1913, a break on the eastern canal bank, opposite the town of Culebra, resumed an activity which began some weeks before. The excavated surface at the bottom of the canal near the center was lifted up for a distance of one thousand feet. This upheaval had a maximum elevation of as much as thirty feet. This phenomenon is due, no doubt, to a kind of see-saw action. The movement of material down towards the canal increased the weight at this point, which reacted against soft material underlying it and the canal bottom, so that the soft material was pressed down at one point, pushed up at another, thus forming a ridge in the bottom of the canal. At any rate, this seems a reasonable explanation of this and similar occurrences. The same slide repeatedly produced the phenomenon of pushing up the bottom of the canal.

There are two great slides near Culebra, one on the western bank and the other on the eastern bank. These two move toward each other and produce a double effect. They affect a length of canal channel amounting to more than half a mile. Both are north of the two ridges known as Gold Hill and Contractor's Hill, which face each other across the canal. The two slides comprise an enormous total of slipping material. The estimate runs as high as nine million cubic yards. The limits of the movement are located at considerable distances back from the line of the canal. On the eastern side the break goes back to a line one thousand five hundred feet distant from the canal axis. On the western side the break is nearly as far back. The movements extend far up the slopes—in the one case to a level two hundred and sixty-five feet above the canal surface and in the other to a level five hundred feet above. The material is being taken away at the bottom.

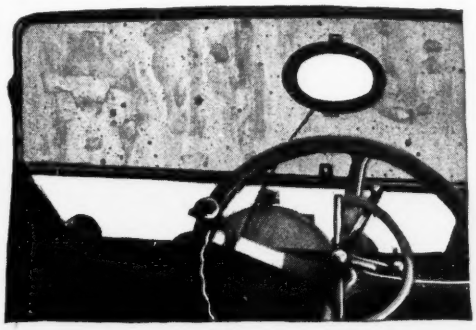
Cucaracha Slide may be counted on to be active at almost any time slides should be working. If the canal had been constructed as a sea-level waterway these slides would probably have been still more active than they now are, because of the greater opportunities with an added eighty-five feet of depth to Culebra Cut.

It seems doubtful whether the movements of earth and rock at Panama are in general due to the steepness of the slopes to either side of the canal. Such an influence may indeed play its part. The controlling cause appears rather to be tilted underlying rock. The mass on the rock moves down however it may be piled up. It seems rather curious, though, that the canal should have been located just where two such tilted rock surfaces intersect each other—that is, just above the bottom of a hidden rock valley.

Drying Rain-Spattered Windshields by Electric Heat

A new device for automobilists has been put upon the market, which when it is raining, dries a portion of the windshield, so that the driver can get a clear view ahead, even when the rain descends with some force.

A metal frame fits closely to the shield and electrically dries the spot inside the oval frame. The drying process is accomplished by a coil of insulated wire resting on the glass and connected with



The metal frame fits closely to the shield and electrically dries the glass

the batteries. These wires supply enough heat to dry the glass within the frame. The frame is equipped with two hooks, two springs, and a cord and plug to connect with the batteries. To attach the device, one hook is placed over the lower edge and one over the top edge, and a spring inserted in each hook, which suspends the frame between the springs. When the plug is inserted in the permanent socket in the dashboard, the glass within the oval clears very quickly.

Protecting Letters Against Mail Box Thieves

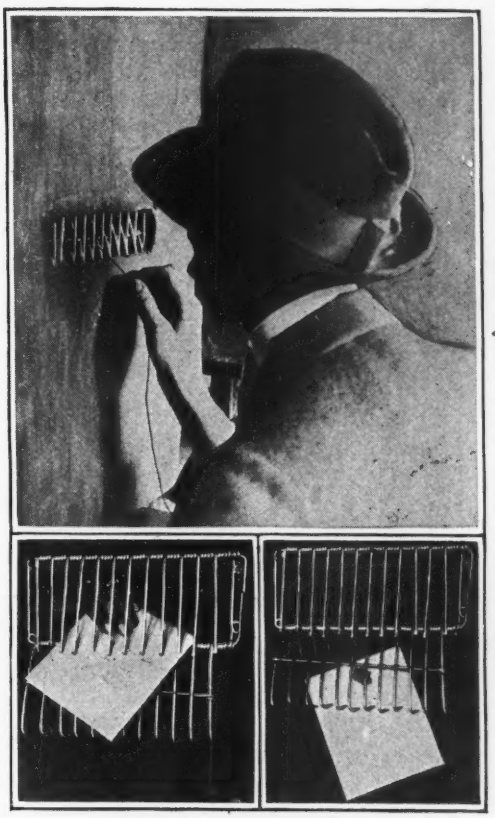
Owing to the various war loans, funds and charities which are being raised in England, the large amount of money passing through the mails has proved a great temptation to petty thieves. Great numbers of valuable envelopes have been removed from letter boxes with the aid of a piece of string and a bit of American chewing gum.

An ingenious inventor has recently devised a simple and inexpensive protection against such thievery. Two rows of wire, each having a sharpened hook at its end, are placed in a spring inside the opening of the box. One of these rows is held up by the springs, and the other is sprung downwards. A letter may be easily passed through the slot, as the springs allow the wires to disengage, and permit the unhindered passage of the envelope.

When a thief attempts to extract a letter from the box, the sharp hooks catch the paper and prevent its removal.

It is said that the inventor has fitted thousands of these devices to the mail boxes of banks and other financial and business houses in London.

The average increase in retail prices of food products in the twenty-five leading towns and cities in New Zealand for the year ending July thirty-first, 1915, was twelve per cent. The greatest advance was in the prices of groceries.



Two rows of hooked wires permit of easy insertion of letters, but defy the letter-box thief who, as shown in the upper picture, tries to steal letters with a piece of chewing-gum on the end of a string

A Cuban mountain-going vehicle remarkable for its comfortable riding

Curious Vehicles Used in Cuba

Two old vehicles which are now rapidly disappearing from the streets of Cuba are the *volanta* and the three-wheeled, glass-encased peddler's push cart.

Prior to 1898, when Cuba was a colony of Spain, these vehicles were to be seen everywhere. The *volanta,* with its long shafts, its team of horses and rider, was admirably adapted for the mountainous regions, and was a general means of rapid transportation. Nowadays, it is seldom to be seen—except in the mountains, where it is still too well suited to the conditions to have entirely disappeared.

The Cuban peddler is giving up this ancient vehicle for carts with better display space

The peddler's cart shown was also familiar. Like the *volanta* it is passing fast. A few are to be seen in the poorer quarters of cities, but in a few years will be seen no more.

Seeing the Panama Canal in a Chair

By means of forty-eight phonographs equipped with a number of duplex telephone receivers, visitors to the Panama Canal exhibit at the Panama-Pacific Exposition listen to a lecture while they are being carried around the exhibit in observation cars.

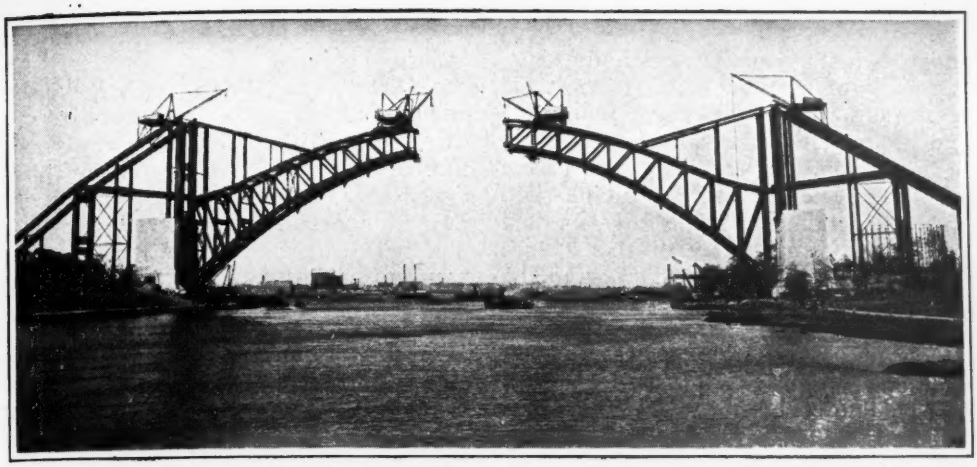
The cars, in which the sightseers sit and are drawn around the perimeter of the huge oval model of the Canal, are each equipped with a set of these phonograph receivers, arranged to deliver the series of fifteen lectures which are given on each trip. The receivers are conveniently hung on hooks on the backs of the chairs, and by fitting them over his ears, the visitor may hear a most comprehensive description of the Canal and its operation.

Listening to lectures on the Panama Canal as they travel in observation cars past a reproduction of the Canal

Heat Improves Concrete

At the present time, when concrete is a common and widely used building material, it is most important to know what effect temperature has upon its strength.

The Engineering Experiment Station of the University of Illinois has made exhaustive tests upon concrete at different temperatures and has made several important deductions. Concrete which is maintained at a temperature of sixty to seventy degrees Fahrenheit will, at the age of one week, have practically double the strength of the same material which has been kept at a temperature of thirty-two to forty degrees. Uniform temperature gave steady increase in strength with age.



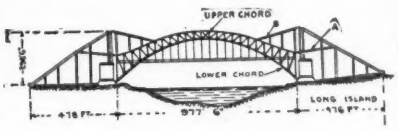
Completing the great Hell Gate Arch. Parts of the material which will eventually be built into the bridge itself are holding the two arch members temporarily in place

Building the Largest Single Span in the World

By C. E. Drayer

THE erection of an arch by the cantilever method makes use of the same principles as the swimmer does when he fastens down his springboard. Backstays must be of sufficient strength and anchorage to hold the arch up as it grows out from its abutments.

To lay out in the field a huge structure nearly a fifth of a mile long, like the Hell Gate arch, just completed in New York City, with nothing more stable than water between the abutments, yet with such accuracy that every rivet will fit exactly according to a predetermined plan, is a task of the utmost nicety. In the Hell Gate arch the abutments were located by the "triangulation" method. A base line several hundred feet long located conveniently on the shore, was very exactly measured, correction being made for the stretch, sag and temperature of the tape. From the opposite ends of the base line, which had a definite relation to the points to be located, known angles were turned with transits so that the point of intersection of the lines of sight through the telescopes of the transits was the point to be located. Assistants marked the point of intersection very carefully. Again and again the angles were read until all possible error was eliminated.



A general elevation of the Hell Gate bridge, showing how the arch was temporarily supported

If at all possible, in work of this character, the distance from abutment to abutment is checked by direct measurement with a steel tape before the erection of the structural work is started. On the Hell Gate arch a specially constructed steel tape one thousand and fifty feet long was used. This tape was three-thirty-seconds inches wide and one-thirty-second inch thick and its end graduations had been carefully checked at standard pull with the tape supported from end to end. When the tape was supported at each end only, a pull of seventy-one pounds was required to correct for sag. This pull was applied by a spring balance and turn buckle rod at one end of the tape. When correction had been made for temperature, it was found that the distance obtained by the tape exactly checked that obtained by triangulation.

But all this careful work in the field pre-

supposes just as careful work in the shop. Assembly of portions of the arch at the shop was required to make the joints true and assure an accurate and easy fit in field erection. So several panels of the arch were laid horizontally in the shop and connection holes carefully marked and drilled. Usually the entire structure is laid out at one time in shop assembly, but the tremendous size of the Hell Gate arch made that plan impracticable.

As the arch unfolds, panel after panel, additional weight is added, which causes deformation in the steel already in place. This must be computed for each member and an allowance made in the shop for the stretch in the upper chord and shortening in the lower chord. Each member must be made a little shorter or a little longer, as the case may be, to neutralize the deformation it undergoes in erection. Naturally the correction made in each individual member is small, the large correction of perhaps a foot at the crown being due to the cumulative effect of the individual corrections.

The junctioning at the crown offered no particular difficulty in this great arch, as the halves meet in a simple butt joint, afterwards riveted into a solid connection.

In the Hell Gate arch, the first attachment of the backstay was at the end of the upper chord (*A* on diagram). When the overhang became too great, a second attachment was made (*B*) which was strong enough to carry the arch and the two great traveling cranes used to hoist the steel to position until junction was made at the crown.

Temperature plays an important part in bridge building. Steel contracts when cooled and expands when heated, and the engineer must make special provision for these temperature changes in the structure he designs. In the ordinary truss, expansion is taken care of by roller bearings at one end. For a span of four hundred feet the change in length due to temperature would amount to nearly three inches from zero to ninety degrees Fahrenheit.

But in a bridge like the new Hell Gate arch, whose ends are firmly fastened to massive concrete abutments, this expansion must be cared for in a different way. The arch rises and falls like a huge thermometer, so that over the range of change in temperature experienced by New York during a year there will be a change in the elevation of the crown of the arch of nearly a foot.

A Binder on Skids

Unusual weather conditions in the western states presented many difficult problems during the harvest season. Flooded wheat fields gave ample opportunity for the demonstration of inventive ability on the part of the farmers.

Perhaps the most interesting device used by a farmer to save his wheat crop was that of the Kansas farmer who made a pair of skids for his binder. The muddy, soggy condition of the field made it seem impossible to use the heavy machine. In some parts of the field water was standing, but this farmer was able to save every bit of his wheat crop, as the skids carried the binder through the muddy field without trouble.

This Kansas farmer saved his wheat crop by running his binder on skids over the water-soaked fields

The Fatal Hum of the Submarine

By William Dubilier

The author of this article is an American electrical engineer, who went to Europe, at the invitation of one of the Allies, to devise a system of harbor defense against hostile submarines. Thanks to his work, it is now impossible even for a submarine travelling under water to enter an English or French harbor without being detected. His interesting article describes the experiments which led to the adoption of a remarkable microphone submarine detector.—EDITOR.

LET a submarine dive below the surface of the sea and it would seem utterly impossible to locate her. No eye can see her. If she plows along at a depth not greater than a hundred feet she can be seen in clear water from an aeroplane. But if she descends below that she is as invisible as any fish.

Suppose that a submarine gave forth a sound of some kind, would it not be possible to devise some form of apparatus by which it could be heard? That was the starting idea of the experiments that I conducted for the allied Government. It is not a new idea. Professor Tissot was hard at work with the original experiments and had already used microphones for this purpose. Professor Fessenden had made some brilliantly successful experiments with an apparatus of his invention, known as an "oscillator," which showed how easy it is to locate a steamship in a fog or at night, provided that it sent forth sound waves. Tests of his instrument had also been made on submarines.

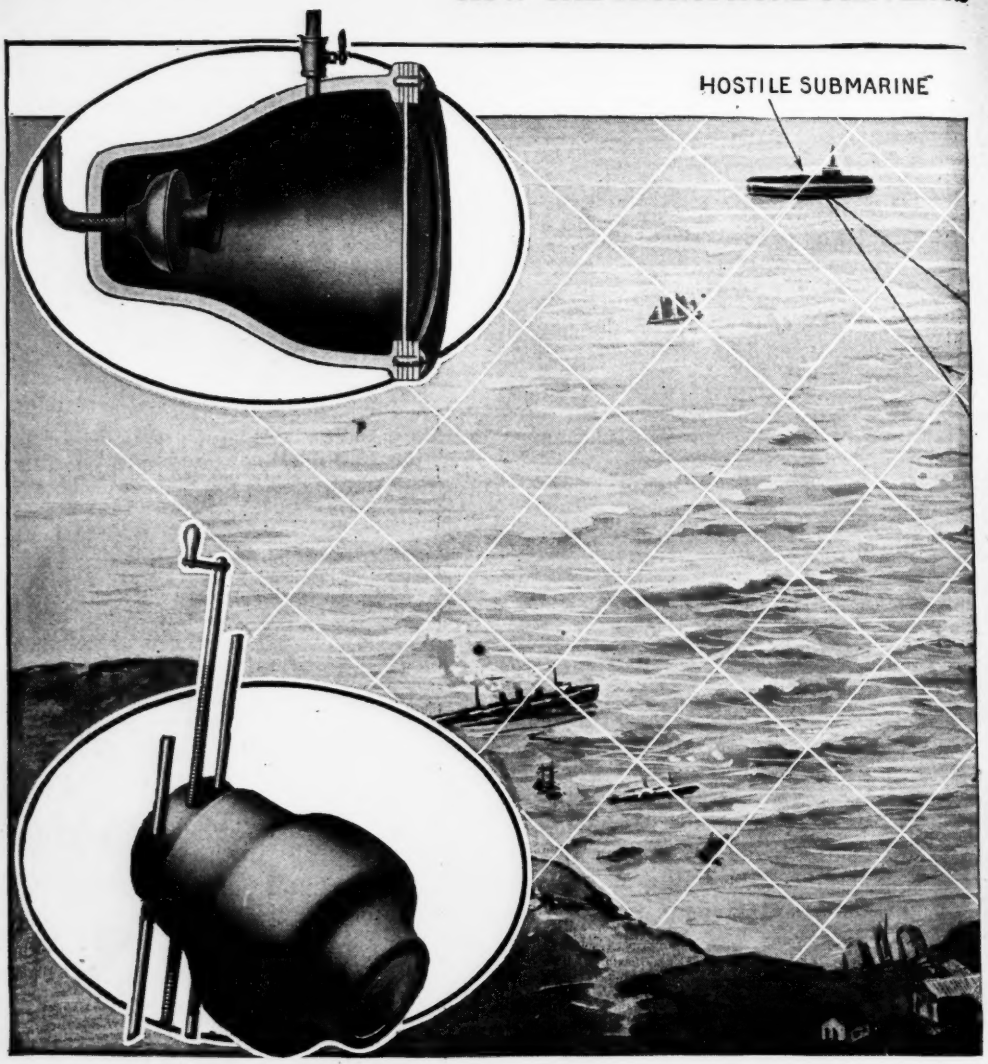
But these investigations were all conducted with a device which was installed for the deliberate purpose of making a rhythmic noise to be detected. What was needed was some form of apparatus which would pick up the sounds sent forth by a submarine, not deliberately, but involuntarily.

Mr. Dubilier holding in his hand one of the small microphones which he used in his experiments

Strange Noises of the Sea

At once the beating of the propellers of a submarine suggests itself. It is not characteristic enough. Motor boats, steamships, and other power driven vessels have propellers, and although their period of vibration is different from that of any other engine-driven craft, some other sound must be sought—something as distinctive as the call of a robin or the neighing of a horse, something that by no possible chance can be mistaken for another sound.

I found what I sought in the weird, shrill hum of a submarine. Others had heard that hum long before I began my experiments. It was taken for engine vibration. But it is much too high in pitch for that, as I found by actual tests. A ship's engines pound out vibrations not greater in frequency than fifteen a second. You can almost count the beats. A propeller has a period much higher, but not high enough to produce the unmistakable insect-like droning that comes from a submarine under the



The harbors of France and England are mapped out in imaginary squares, each bearing a number. In two stations, A and B, located a measured distance apart, microphone detectors are located. The stations A and B are in telephone communication with the wireless station C. The officer in station A adjusts his microphone until he hears the hum of the submarine most plainly; the officer in station B does the same. Imaginary lines drawn perpendicularly to the microphone diaphragms will meet at the exact spot where the submarine is to be found. The necessary calculation is performed in the station C, for the officer there in charge knows the exact distance between A and B and the angles

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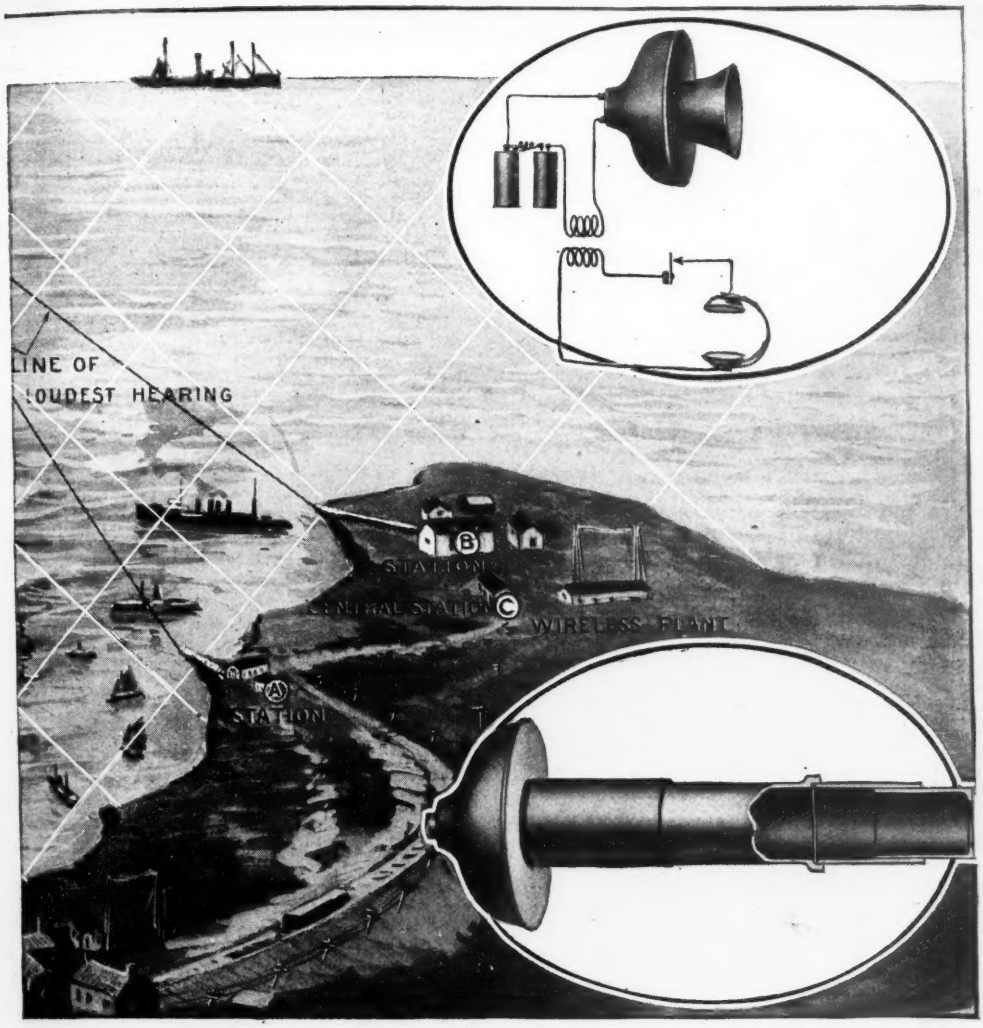
(Upper Left-Hand Oval Insert:) First experimental microphone and container. This form of electrical ear heard too much because it was influenced by passing steamers as well as submarines. The hum of the submarine was drowned out by the pounding of steamer engines and the beating of propellers

(Lower Left-Hand Oval Insert:) The microphone and containers were suspended as shown. A threaded rod, with a handle at the end, passed through a central hole. Two outer holes slid over guide rods. It was possible to screw the microphone up or down or to throw it bodily from side to side until the hum of the submarine was heard most plainly

(Upper Right-Hand Oval Insert:) In the upper right-hand oval picture a system is shown which was experimented with in order to eliminate all sounds but the hum of the submarine. This involved the use of a contact maker and breaker which made and broke the circuit with the same frequency as that of the submarine's hum. There was only one

SUBMARINES FROM ENTERING HARBORS



made with the base line A-B by the imaginary lines running to the submarine. A very quick calculation enables him to determine exactly in what square the submarine is to be found. He sends a wireless dispatch to a torpedo boat to proceed at once to square 23 or 25, as the case may be. As the submarine moves, its direction is telephoned by the officers in stations A and B to the officer in station C. By wireless, the officer at C directs the course of the torpedo boat so that it follows the changing direction of the invisible enemy. Unless the submarine drops to the bottom and stops its motors, it must be inevitably caught when it rises to the surface

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circuit at first—a battery, a microphone and a receiver. If a contact breaker were put into this circuit, naturally a continuous noise would be produced, due to the rhythmic breaking of the circuit. By inserting a transformer and placing the contact breaker in the secondary circuit, this difficulty was immediately eliminated. In technical parlance, the contact breaker was of such a type that the phase could be shifted so that the waves would be broken at the crest. The system was fairly successful, but not altogether trustworthy. It eliminated extraneous noises, but sometimes it also eliminated the very submarine hum which the experimenters most wanted to hear

(Lower Right-Hand Oval Insert:) Eventually, a telescoping resonating tube was adopted, which was attached to the diaphragm, and which, being attuned to the hum of the submarine alone, excluded all extraneous sounds, such as the vibration of engines of passing ships and the beating of propellers

surface of the water. The period of vibration is about seven hundred and fifty a second. To produce a hum so high in pitch a propeller would have to revolve at a speed much greater than we dare to give to the flywheels of steam engines.

The Hum of a Power House is Identical With That of a Submarine

I soon convinced myself that the fine, shrill, almost singing note that can be heard when the Diesel engines are cut off and the submarine is traveling under power derived from her storage batteries is due entirely to her electric motors. The sound is unmistakable. Step into any central station where electric power is generated to light a city and you will hear the hum of a submarine. There is no difference to the ear. To devise a means of detecting this sound at great distances was the object of my experimenting.

The microphone at once suggested itself as a suitable instrument.

In my first attempts to detect submarines by their characteristic hum, the microphone was sealed within a watertight container and the whole placed in the water. The apparatus was a failure. It could not withstand the pressure of water even at five fathoms. The container was crushed like putty in a strong hand. Since the depth at which the microphone was expected to work might reach forty fathoms, where the pressure was hundreds of pounds to the square inch, it was obvious that some method of resisting the water had to be devised. The container had a diaphragm on one side, against which the sound waves from the submarine impinged. Because of the water pressure the diaphragm could not vibrate freely, and hence the microphone was highly inefficient.

Ears That Heard Too Much

In order that the diaphragm might successfuly resist the external pressure air was forced into the container until its pressure equalled that of the water. The new form of apparatus was much more successful than that first used. Submarines could be heard beneath the water at a distance of five miles, and the apparatus stood up well, even at great depths. But it had the great defect of hearing too much. Not only was the hum of a submarine picked up with astonishing clearness, but other strange sounds of the sea as well—the vibration of engines in passing steamers, the beating of propellers in water. A steamer sets the water vibrating with an intensity thousands of times greater than that of a humming submarine. In that deluge of sound the submarine could not be easily detected. It was like trying to hear the thin, clear note of a violin under a railway trestle while a train was passing overhead. A kindred phenomenon is observed in radio stations. The wireless operator calls it "static." He eliminates static by tuning his apparatus to respond only to the signal that he wishes to detect.

In order to make the microphone effective an analogous system of mechanical tuning was invented. It was necessary to eliminate all sounds but that emanating from the submarine to be located. You can understand how that is possible if you have noted the response of a piano to a violin. Draw your bow over any of the violin strings and sound a single clear note, and you will hear a faint response from the corresponding string in the piano. Of all the strings in the piano only that one answered the violin. Why? Because that was the only string in tune with the violin note.

The Invention of a Sound Sieve

Clearly, some kind of sound sieve was wanted—something that would sift out everything but the singing submarine.

Years ago an instrument maker, named Koenig, at the University of Paris, devised an adjustable resonator. It consisted merely of two telescoping metal cylinders. The cylinders were closed at one end except for a sound opening. If you wanted the cylinders to sing in unison with a vibrating tuning fork, you could do so by moving the cylinders upon each other. A point would be reached at which the natural period of vibration of the air space within the cylinders was exactly equal to that of the tuning fork, with the result that the resonating cylinders gave forth the same note as the tuning fork. While the cylinders were thus adjusted they would respond to no other

note. Still, they could be made to sing in unison with any other tuning fork merely by adjusting the telescoping cylinders.

Playing a Flute to Analyze the Hum of a Submarine

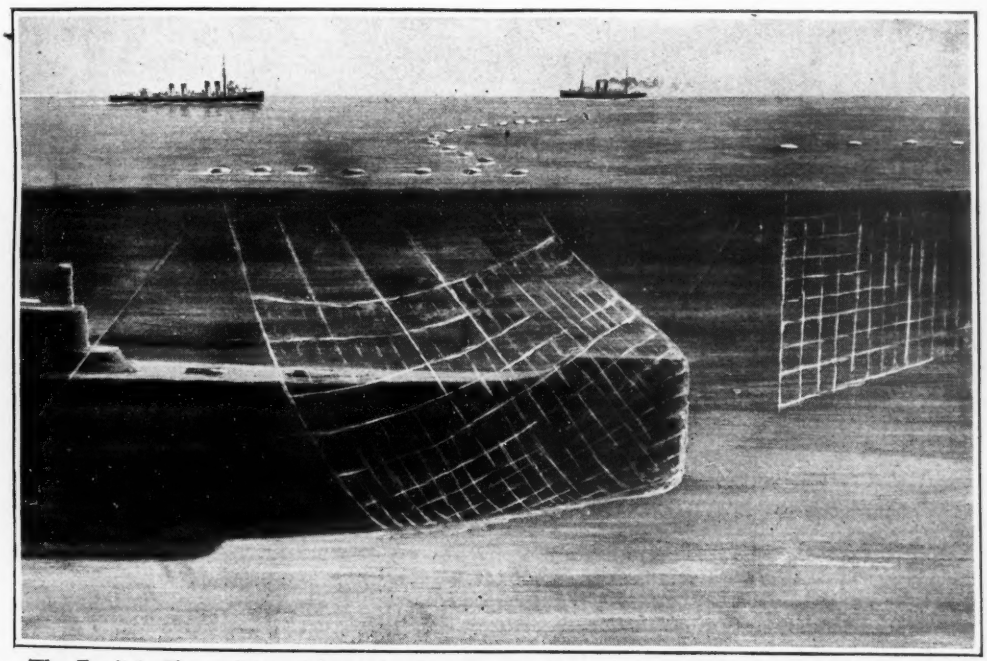
It was this principle which was applied in the construction of a microphone which would respond to nothing but the singing electric motors of a submerged submarine. In front of the diaphragm of the microphone-container a telescoping tube was secured. To ascertain the natural frequency of vibration of a submarine's electrical machinery a flute was played. It was found that a note could be extracted from the flute which corresponded exactly with that emitted by the submarine. Experiments were then made with the flute in front of the resonating diaphragm tube. By pushing the tube in and pulling it out it was finally adjusted so that it sang with that note of the flute which corresponded with the hum of the submarine.

The result was startling. The microphone now responded to nothing but the humming submarine. Ocean steamers with great pounding engines within them passed unheard. Only the high-pitched note of the submarine reached the ear. A French submarine and a torpedo boat destroyer were placed at my disposal for experimental purposes. The sounds from the two never clashed; the submarine alone was heard.

Other forms of sound receivers were tested, and we finally adopted one which gave most satisfactory results. In front of the resonator tube a diaphragm was mounted, and to this a second resonating tube was attached. The double-tube resonator was placed within a heavy casting provided with a diaphragm, and into this container compressed air was pumped to offset the water pressure. One of the inserts on the double-page illustration shows the construction so that further explanation is unnecessary.

The Electrical Ear and How it Hears

This microphone, or electrical ear, as it may well be called, proved to be extraordinarily sensitvie. It could detect a submarine twenty miles away. And it behaved curiously like a telephone. Talk squarely into a telephone transmitter and



The English Channel is a labyrinth of nets. They are suspended from floats. When the floats are straight, the English patrols know that nothing of moment has happened below the surface; but when they are askew, as in this picture, they know that a submarine has been caught

the man at the receiver will hear you clearly; talk into the transmitter sidewise, and you will be heard less distinctly. So it proved with the microphone. When the singing note sent out by a submarine under water struck the microphone squarely it was heard much more distinctly than if the microphone were inclined to the sound waves. That made it easy to note in which direction the submarine was traveling. The microphone had merely to be turned until the hum was heard most distinctly.

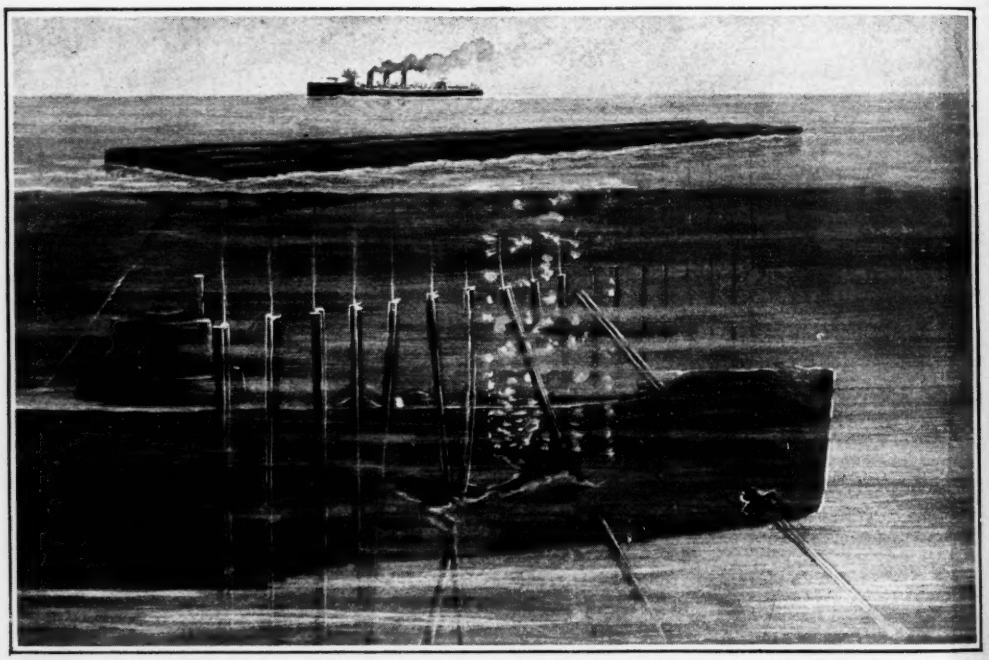
To determine the exact spot where a hostile submarine might be at any given moment two microphones were employed. Imagine two stations, *A* and *B*, along a coast line; imagine a microphone detector in each, and imagine a central station, *C*, the headquarters of a naval officer in telephonic communication with stations *A* and *B*. The microphone detectors at stations *A* and *B* are turned from side to side until the submarine is heard with the greatest distinctness. Imaginary lines drawn perpendicularly from the microphones would meet at the point where the submarine is to be found, and the length of the line can easily be calculated by a simple trigonometrical process.

For the purposes of defense the harbors of the world are usually ruled off by artillery officers into imaginary squares, which are plotted on a map. Suppose that a submarine is in square 23. The officer in the central station *C* is told by the microphone operators in stations *A* and *B* the exact inclination of their instruments at the moment. He carries out a rapid trigonometrical calculation, and the result shows him that the submarine must have been in square 23 at the time his data were telephoned to him. At once he sends out either a fast motor boat, armed with a gun, or a torpedo boat destroyer, to square 23.

Tracing the Course of an Invisible Submerged Submarine

But, you naturally object, the submarine under water is not at rest. It is moving at the rate of ten knots. By the time its pursuer reaches square 23 it may be in square 35.

The objection is very easily met by wireless. As soon as the pursuing boat starts for its prey its wireless operator



Below the surface of the water a submarine is sightless, for the periscopes have been withdrawn. The British have taken advantage of this. Railway rails are suspended from a raft, as here shown. If a blind submarine collides with them, its shell is crushed in. Death and destruction inevitably follow

listens for signals from the central station *C* on shore. The men in stations *A* and *B* follow the moving submarine with catlike vigilance, each second. They turn their instruments this way and that, always listening, until the sound that comes to them is clearest. They telephone from minute to minute to the central station. "Heading north east" is the word from station *A*. "Heading north northwest," telephones the man at station B. And so, the course of the invisible terror beneath the waves is constantly followed with an accuracy that must seem as uncanny as it is simple.

The Blind, Helpless Submarine

The captain of a hostile submarine has no means of knowing that he is pursued when he is submerged. He is absolutely blind. His periscope avails him not. Sooner or later he will rise to the surface, like a whale, if not to blow, at least to see. Certain destruction awaits him. The instant his periscope juts out of the water a hail of bullets rains upon his deck. His enemy rushes upon him, rams him and crushes in the thin shell of his submarine like paper.

The experiments here described resulted in a complete defense against submarines lurking in harbors and waiting for a chance to torpedo a vessel about to put out to sea.

Obviously the same principles can be used on shipboard. I have myself conducted experiments along lines indicated by Professor Tissot and Professor Fessenden with encouraging results, and I know that microphone detectors are now used on English ships to pursue as well as to avoid German submarines.

If the Germans practically have abandoned submarine warfare, it is not only because the volume of British shipping is so enormous that a hundred submarines could not hope to wipe it out completely, but also because the microphone has been able to ferret out underwater craft, even when submerged at great depth.

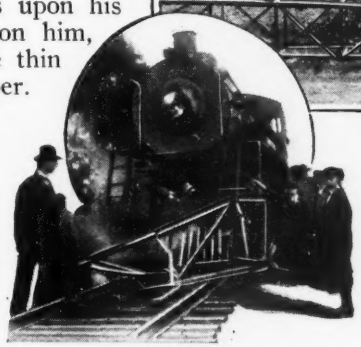
The first American linotype machine has recently arrived at Tripoli.

Wireless Tower Wrecked by a Gale Stops a Train

During a terrific gale last fall the new three hundred and four foot wireless tower at Tufts College, Massachusetts, was blown over and a section dropped thirty feet in front of an express train speeding to Boston. The quick wit of the engineer in throwing on the brakes and reversing the throttle prevented a very serious accident.

The tower carried away telephone and telegraph wires and also blocked a main arm of the railroad for several hours.

The steel structure was to have been the highest wireless mast in New England, the foundation being ninety-six feet above sea level, making possible radio connection with Europe. An umbrella antenna was planned to radiate from the top, but had not been installed at the time of the accident.



The tower of the Tufts Wireless Station fell directly across a railway track

The wireless tower, wrecked by a gale of wind, lay on the ground twisted like a snake

This was the only tower of its kind in the country and the height was to have been increased to five hundred feet. Guy wires supported the tower at every one hundred feet, but were not sufficient to support it adequately against a high wind. The hollow steel structure was about six feet square from top to base.

During 1914 the marketed production of natural asphalt in this country was 77,588 short tons, with a value of $630,623.

Removing the Rim from the Tire

A tool has been designed which is intended to lessen the labor of taking off rims. It removes the rim from the tire, not the tire from the rim —the ordinary method. No hammering or prying is necessary, and the rim and tire are therefore undamaged by the operation.

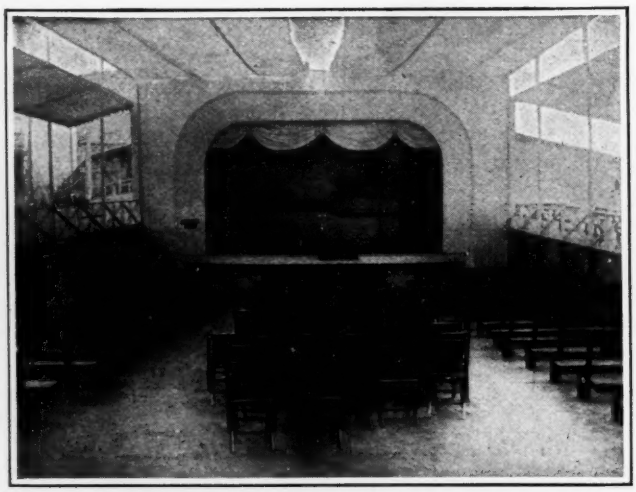
To remove the rim the tool is placed with the three hooks over the edge of the rim and the lever pressed down. This motion contracts the rim, causing the one end to lap over the other, and the whole to come off the casing easily. The tool consists of a handle, to which are attached three arms with hooks, and a lever. When pressed down this lever causes one arm to be pulled, thus loosening the rim and lapping that end of the rim under the other end.

Wobbly wheels, caused by hammering them off, are impossible when the tool is used. The remover can be used with any split rim now in use, and a modification of the device is made for use on solid rims.

This clever tool reverses the usual tire-changing process. It removes the rim from the tire, not the tire from the rim

From Swimming Tank to a Theater

A queer transformation made in a big amusement park at Ocean Beach, Cal., is the change from a large concrete pool, originally used for diving and swimming performers, to a theater pit for the free vaudeville staged on the boards at the end. After the tank was remodeled at the shallow end to allow the audience to walk down an incline, a stage was fitted up at the deeper end, and the seats were set on the concrete floor in rising tiers. The gradual rise of the floor of the pool from deep water to shallow water gave just the right slant for the seating, so that every spectator may see over the heads of all in front of him. A canvas roof and side-supports were added to complete this novel outdoor vaudeville house.



A stage was set up at the lower end of this swimming tank, and the inclined floor gave the correct slant for the seats. The pool seemed made for its new purpose

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It is estimated that by mere waste, caused by coins rubbing together, the world loses one ton and a quarter of gold and eighty-eight tons of silver annually. Gold coins are said to be rolled in barrels by the Chinese for the dust knocked off.

A private automobile for a sixty-thousand-dollar race horse

A Motor Car for a Horse

In order to keep the famous race horse "Uhlan" from the dangers and draughts of an ordinary railroad horse-car, Mr. C. K. G. Billings, the famous horseman and "Uhlan's" owner, has built a large motor truck in which the horse is transported from race to race.

A large, box-like body was built on the truck chassis, high enough to clear the head of the standing animal. The inside of the car is padded, and even if the car should rock and sway on its heavy springs the horse would not be injured.

"Uhlan" is valued at over sixty thousand dollars. As a highly trained race horse is subject to colds, the utmost precautions have to be taken.

A car very similar to the one used by "Uhlan" is at present in the service of the American Ambulance in Paris. Instead of carrying one race horse, the machine now carries fourteen wounded men at a single trip.

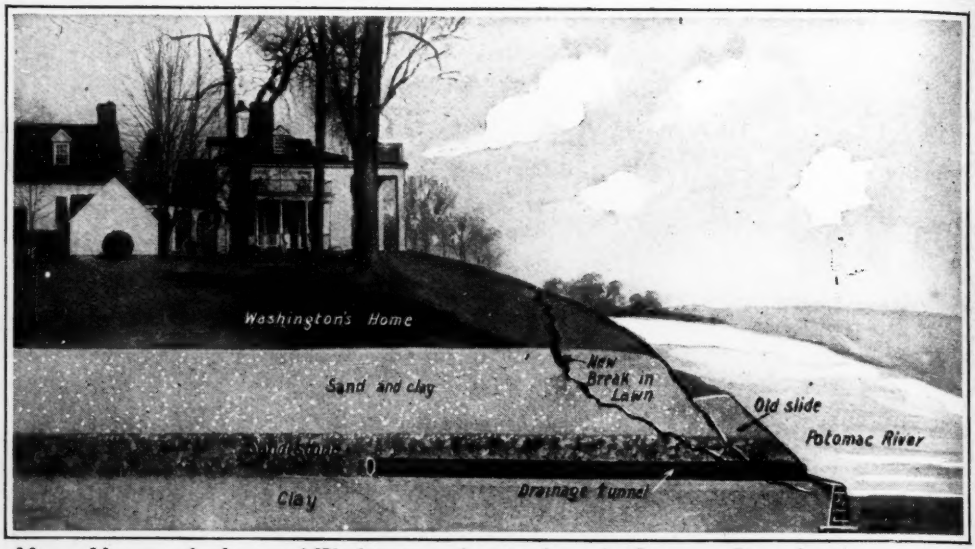
Training Militia Officers at Army Aviation School

An announcement of Secretary of War Garrison to the Aero Club of America states that in the near future officers of the Flying Corps of the militia of the various states will be given training at the United States Army Aviation School at San Diego, California.

Provision is made for mileage, subsistence and quarters of those who are authorized to attend, but pay from the Federal funds during the period of attendance is not authorized.

It is doubtful whether any officers of the militia can be trained at the present time at the school, as it is already so short of aeroplanes that instead of having two or three for each officer-pilot, as they have in European countries, a number of army officers have, together, only one machine in which to train. Consequently a number of officers, because of lack of equipment, cannot get sufficient practice.

Sixteen states have become interested in the formation of a Flying Corps through the Aero Club's efforts, and are now ready to take up the work of developing this branch of the service as soon as they can get funds for aeroplanes and for the upkeep of the corps. These states are: Arizona, California, Illinois, Iowa, Florida, Maine, Missouri, Nebraska, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Texas, Vermont and Wisconsin. Several of these states are already provided with aeroplanes. New York has two machines, an aeroplane and a flying boat; the latter for the use of the Naval Militia.



Mount Vernon, the home of Washington, showing how the Potomac River had been eating into its banks and what the engineers have done to save it from further attacks

Saving the Home of Washington

OF the thousands of Americans who have enjoyed the magnificent view of the Potomac from the broad lawn of the mansion at Mount Vernon, few, if any, realized that the bluff on which the home of George Washington stands was in danger of sliding into the river and being washed away.

This bluff is about one hundred feet high and is composed of layers of clay, sand and soft sandstone over a stratum of impervious clay. Undercutting of the foot of the bluff by the river and the fact that the soft sandstone over the clay was continuously wet, resulted in landslides, which doubtless have occurred more or less frequently for centuries. In Washington's time, a part of the steep slope from the edge of the lawn to the river broke away and slipped toward the river.

Recently it was discovered, by finding a break in the lawn in front of the mansion, that a new slide had developed. If it were not stopped, it would destroy at least a part of the lawn and the beautiful trees along the bluff and might eventually extend back until the mansion itself was endangered.

Two methods to stop the earth movements were discussed. One was to hold the earth back by driving piling. But this was like making local applications without a thorough diagnosis of the case in order to remove the cause. The other method was to make a study of the strata which made up the bluff and the underground water, and then to see if the water could not be drained off. This second method was adopted as the one which would likely result in permanently stopping the slide.

The surface of the clay was the plane on which the bluff was sliding. A small drainage tunnel was driven into the sandstone at the level where it joins the clay below. A considerable flow of water started at once from the tunnel and kept up for several months. Then the flow gradually diminished until it is now relatively small and constant.

The diagnosis of the engineer was correct. With the removal of the water from the overlying strata, and from the sliding plane under the sandstone, the earth movement has stopped. At the water's edge a masonry retaining wall has been built to stop the undercutting of the bluff by the wave action of the river. No further trouble is likely to occur now that the causes of danger have been removed.

Wireless Telephoning Simply Explained

By John L. Hogan, Jr.

NOT long ago newspaper readers were surprised to learn from newspaper headlines of the startlingly successful transmission of wireless telephonic speech from Arlington, Va., westward over the entire North American continent to Mare Island, California, a distance of two thousand, five hundred miles. This was astonishing enough, but when the next morning's papers reported that human speech had been transmitted wirelessly as far as Honolulu, Hawaii, about five thousand miles of land and sea, the earlier result was completely eclipsed. Later still, Arlington talked wirelessly with the Eiffel Tower in Paris, across the Atlantic Ocean.

For the past two or three years wireless telephony has not been largely advertised; in 1908 and 1909, however, its possibilities were greatly over exploited. As a result of the absence of publicity since about 1912 the new accomplishment of talking four thousand, nine hundred miles comes before us as an indication of a radical change from former methods of wireless telephony; the inference is that, since the distance covered is great, some real change of principle has been made. Nothing could be farther from the actual fact; wireless telephony in its earliest days was effected in exactly the same way as it is today. Increases in distance have come mainly as a result of using more powerful sending instruments and more sensitive receivers. The development of these devices is a matter of great importance, and has been a tremendous undertaking. Nevertheless, it should be remembered that wireless telephony itself is not a new thing. The transmission of articulate speech by modulated ether waves of the sort used in wireless telegraphy has been accomplished many times since its inception in 1900 or thereabout; radio-telephony, as this modern sort of "wireless" is officially named, began some fifteen years ago with poor communication by simple words over a distance of approximately one mile. The speech as first received was masked by interfering sounds, much as on a noisy telephone wire, but the defects were eliminated one at a time, until, in 1906, it was demonstrated that over distances of some twelve miles wireless conversations were clearer and better than those held over wire. The next year radiotelephony was demonstrated as an operating possibility when Fessenden wirelessly transmitted speech from Brant Rock, near Boston, Mass., to New York and Washington, distances of two hundred and four hundred miles respectively.

What Is Wireless Telephony?

The interest aroused by the new work of the American Telephone and Telegraph Company, whose engineers are largely responsible for the development of the specific instruments used in telephony from Arlington to Honolulu, has caused much speculation as to what radiotelephony really is. The idea of sending articulate sounds for miles over a wire and then reproducing them seems weird enough, but when the same process is accomplished without any visible connecting medium, except the earth, the result seems more than ever mysterious. Yet when one understands the natural laws which are applied in transmitting speech electrically, one seems no more marvellous than the other. Speech itself is not looked upon as wonderful, yet the mechanics of articulate sound are little less complicated than those of telephony.

To understand the real action of wireless telephony it is necessary to realize what speech itself really is. Vocal sounds, like all others, are produced by mechanical vibrations which reach the ear (usually through the air) and there cause similar vibrations in an auditory system, thus producing upon the brain the sensation of sound. In the production of speech waves, air is expelled from the lungs and, passing through the vocal system of the throat and mouth, is set in vibration. Nervous control of the organs of speech permits us to alter the vigor and frequency of the air-vibrations produced, and to combine the various frequencies of vibrations as we may

choose. This faculty gives us the ability to signal to our neighbors according to the conventional sound-code called "language." In considering this it must be noted that the air lying between a speaker's mouth and an auditor's ear does actually move with the energy of the speech waves. The motion is not that of a current, for the air particles do not pass the entire distance from speaker to hearer, but is rather that of a series of impacts between successive molecules of gas in the atmosphere. In case a simple clear tone is sung, all the molecules oscillate back and forth according to a simple law of vibration. Each one strikes its more distant neighbor and, giving up its energy to it, then rebounds against that by which it was impelled in the first place. When the sound wave to be transmitted is complex, such as that representing a consonant (the letter B, for example), the path traveled by each molecule is also complex; the movement of the particles may be predetermined accurately, nevertheless, by adding together all the component frequencies of vibration which go to make up the sound being transmitted. It is this actual movement of each molecule, with exact fidelity to the vibration which set it in motion, that makes possible the transmission of speech by electricity in either the wire or the wireless telephone.

How the Ear Hears

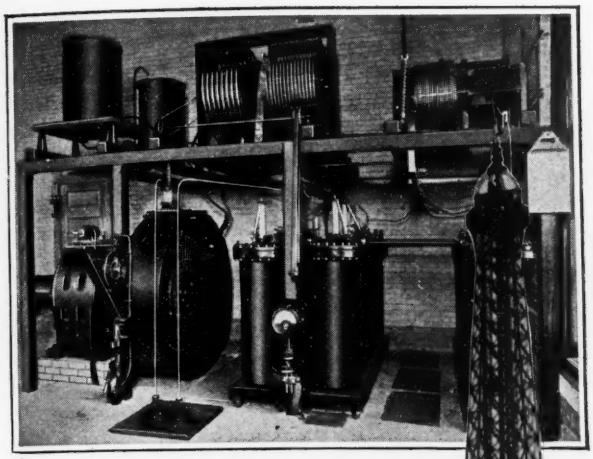
Since sound-waves travelling in air are based upon a purely mechanical motion of the air particles, it is evident that it should be possible to secure a similar mechanical vibration in any body upon which the air waves strike. And this is what happens when a sound wave reaches the ear. The small diaphragm forming the ear-drum is set in vibration with the same frequencies as those which caused the sound-wave.

This ability of the air-waves to produce motion is not confined to effects produced upon the ear-drum, however; any diaphragm offered to them will vibrate in exactly the same way. The motions of such a diaphragm may be registered upon a wax record, as in the phonograph, and the original sounds thereafter reproduced by reversing the recording process and causing the record to move the diaphragm through its original series of paths. Or the motions of such a diaphragm may be used to change the intensity of an electric current, so that the sound variations in the air may be impressed upon the apparatus connected at the distant end of a wire, through the medium of electricity. When the variations in the electric current imposed by the action of the voice are caused to move a diaphragm at some connected point, and force this diaphragm thus to reproduce the original speech waves, wire telephony is accomplished. If the electric current which is modulated or altered in accordance with the original sounds is caused to set up radiating electromagnetic waves in the ether of space, and if these pass to a distant receiving station and there reproduce their original vibrations by causing identical movements of a receiving telephone diaphragm, radiotelephony is effected.

The three processes of speech transmission, viz., mechanically through the air, and electrically by wire or by wireless, are identical in the basic principle that sound vibrations are impressed upon some medium capable of carrying them to a receiver, and there are reproduced. The electrical process is merely a little more complicated by the interposition of a traveling electric current in a wire, or a traveling electromagnetic wave in space. These constantly connect the transmitter and the receiver, and, by changes in character produced by the original sound waves, reproduce their motions at the telephone held to the listener's ear.

The Essentials of a Wireless Telephone Apparatus

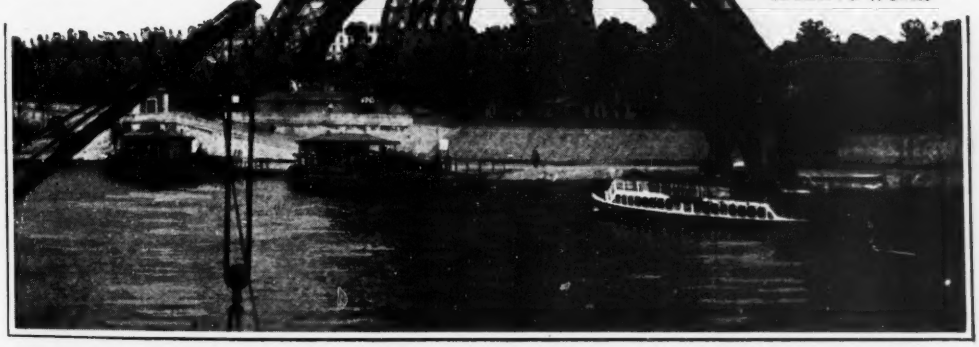
The wireless telephone, then, requires three important elements for its operation. First, there must be a generator of a continuous stream of electromagnetic waves which pass from sending to receiving stations constantly and upon which speech vibrations can be carried. Second, there must be an instrument which will modulate this stream of waves according to the voice vibrations to be transmitted. Third, there must be a receiver which will reproduce accurately the variations in the waves and so make



The powerful radio telegraph transmitter at the Arlington Station, near Washington, by which the human voice was carried to Honolulu and Paris

audible the sounds which are acting upon the modulating apparatus.

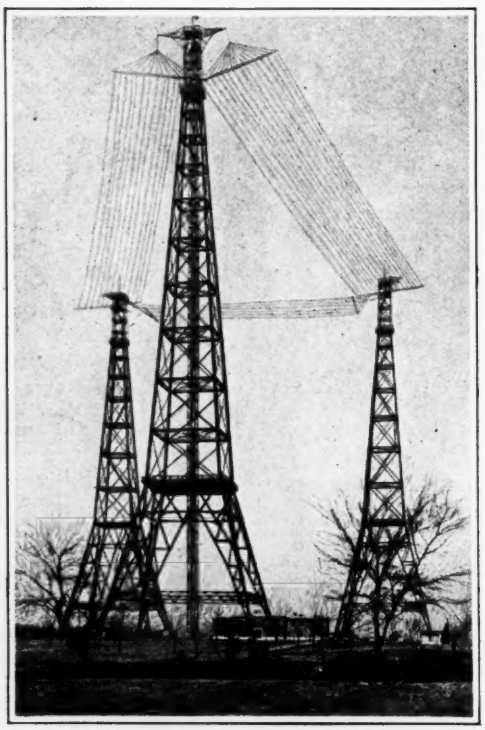
It happens that the generator has been developed to a high degree in connection with work on wireless telegraphy, and that there is now available for the radio-telephone far more wave-energy than it has been found possible to control by speech. In fact, this condition has existed from almost the earliest days of wireless telephony. Fessenden's sparks and arcs of 1903, and his alternating current generators of 1906, Poulsen's hydrogen arcs of 1907, and the later arcs, alternators and spark systems of other investigators, including Goldschmidt, Lepel, von Arco, de Forest, Majorana and Joly, have all been capable of generating more powerful streams of waves than it has been possible to control efficiently. Similarly, the receivers as used in modern wireless telegraphy have more than sufficient rapidity of response and delicacy to reproduce speech waves transmitted by wireless. Further increases in their sensitiveness have been made recently by the addition of amplifying relays to magnify the received sounds, but in every case this increase in sound strength has been accompanied by a disagreeable magnification of disturbing sounds from atmospheric interference which has prevented commercial use of the over-delicate instruments. The real limit of radiotelephony has therefore been in neither the generator nor the receiver, but in the modulating apparatus. It is in the development of this part of the transmitter that the engineers working under Mr. Carty of the telephone company have done their finest and most effective creative work.



The Eiffel Tower, Paris, where the great French wireless receiving station heard the voice in Washington, more than three thousand miles away across the Atlantic. Unfortunately the experiments between Arlington and Paris could not be continued. The Eiffel Tower is so essential in war that the French government has been compelled to abandon its interest in the work

The Bell System Aids the Wireless Telephone

As President Vail said: "So far as the perfection of the wireless telephone goes, there has been no new basic invention, merely a perfection of sending and receiving instruments. Of course, in the perfection of these delicate machines there have been minor inventions." The work of the telephone company on radio, following the inauguration of transcontinental telephony by wire, has been carried forward a step at a time for nearly a year. Speech was first sent from an experimental station at Montauk Point to the New York offices, then two hundred and fifty miles to Wilmington, and then one thousand miles to a specially erected station off the Southern coast of Georgia.



Tower at Arlington, Va., from which the wireless telephone reached Hawaii and Paris at the same moment

The results of these trials were more than enough to indicate still greater possibilities for the apparatus developed in the course of the experiments, and therefore arrangements were made to borrow the antenna of the great Naval Radio station, at Arlington, Va. The new type of transmitter was installed there, and preparations made for radiotelephony over longer distances. On August 27 a successful test was made from Arlington to Darien, Isthmus of Panama, two thousand, one hundred miles away. On September 29, in the early afternoon, speech from New York sent to Arlington, by wire, was relayed to the radiotelephone and transmitted to San Francisco, by wireless, over two thousand, five hundred miles. At the same time the talking was heard at San Diego, California, two thousand, three hundred miles away, and at Darien, Panama. Soon after midnight the engineers listening at a newly installed receiving station near Honolulu, Hawaii, reported that they were receiving portions of the speech direct over the four thousand, nine hundred miles separating them from Arlington, and that, although the words were very loud, they could be understood only when atmospheric and other disturbances were slight.

What's the Good of the Wireless Telephone?

The practical utility of radiotelephony has been much discussed. Generally it is believed that the wireless telephone has at least two fields of service, which are peculiarly its own, to wit, inter-connection of ships and isolated points on land, where it is not economically possible to employ a telegraph operator, and in conjunction with wire telephones as long-distance "trunk" lines.

The special feature of the wireless telephone is the freedom from distortion with which it transmits speech, and this, taken with its elimination of line maintenance expense, indicates a commercial future for the method when the apparatus shall reach a point of sufficient development. The engineers of the telephone company are to be credited with aiding the commercial development of the wireless method. It was largely due to their fine experimental investigations that the magnificent feat of communicating by articulate speech from Arlington to Honolulu and Paris was accomplished.

Special Theater Seats for Children

Nearly everyone has been bothered, when sitting in a motion picture theater, by having a child in the seat just in front of him climb up on the arm of the chair or get into the seat in such a fashion that the child can himself see, but greatly inconveniencing those behind him.

A new invention in the way of chairs, designed by Raymond D. Weakley, of St. Louis, Mo., is expected to do away with this annoyance.

The adult seat is raised nine inches when it is converted into the child's seat

Mr. Weakley's seat differs little in design and construction from the present opera chair. The front two-thirds of the seat portion is bolted to an independent pair of seat-rest castings which are hinged to the forward end of the regular castings. The apparatus makes it possible to push the adult seat forward and upward. The entire seat moves toward the back, where it locks automatically in the new position. With this movement the adult seat, which is seventeen inches deep and fifteen inches above the floor, is converted into a child's seat, eleven inches deep and twenty-four inches above the floor.

As the back and seat of the chair, when in the child's position, are in the same proportion as that of the adult seat of the ordinary opera chair, the child is perfectly fitted, and seated, as in the best public school chairs, while his eye is brought to a level with the adult's.

Children constitute about forty per cent. of the average moving picture theater attendance, and the use of the new style seat is expected to popularize the moving picture theater still more with adults as with the youngsters.

Trawlers in War and Peace

The efficacy of trawlers in Britain's campaign against the German submarine has directed considerable attention during the past few months to these diminutive steamers, built originally for fishing purposes, but through pressure of circumstances commandeered for commerce protection.

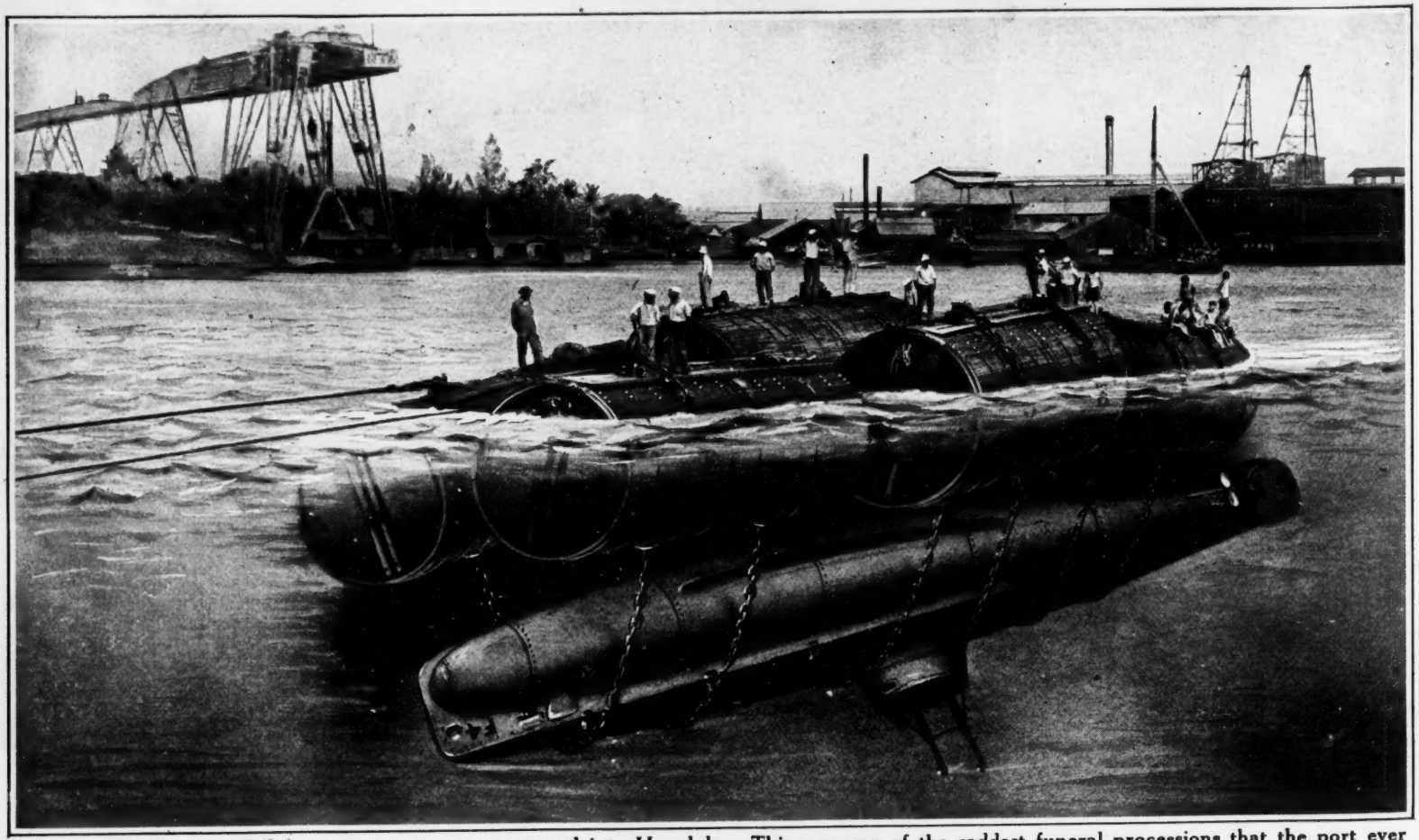
The child can see over the heads of the adults, and does not cut off the view of those behind

As a war vessel, the trawler must rely upon an unvarying rule of seeing the submarine before the submarine sees it. A single shot from one of the trawler's light guns will end the career of a submarine.

Just how the trawler works in time of peace is not so well known. A large net is trolled behind the steamer on the end of a hawser. The cable is fastened to the bow of the boat, and when the net is filled the trawler is brought about in a short circle. The net is then slowly drawn in, hoisted aboard, and the fish sorted.

The nets trail close to the bottom—so close, in fact, that submarine telegraph cables are often dragged from their beds.

THE "F-4" IN PORT—A SUBMARINE COFFIN FILLED WITH DEAD



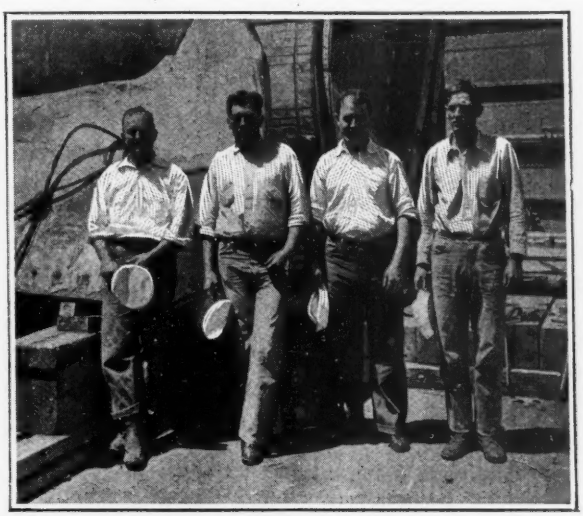
How the "F-4," suspended from six pontoons, was towed into Honolulu. This was one of the saddest funeral processions that the port ever saw. Fifteen met death in the engine-room, where they sought refuge at the last; six died at their posts in the flooded forward compartment. The disaster was caused by a leak resulting from a corroded battery lining and corroded rivets, and the failure of the boat, through poor diving qualities, to respond promptly to a rudder change which should have brought her to the surface.

How the Submarine "F-4" Was Lifted Out of Three Hundred Feet of Water

By Lieutenant-Commander Julius Augustus Furer,
Naval Constructor, U. S. N.

Lieutenant-Commander Furer, the author of this article, planned and directed the raising of the "F-4" in all its phases. Therefore, his highly interesting and simple exposition of the engineering methods employed may be regarded as trustworthy in every particular. A Board of Inquiry, headed by Rear Admiral Busch, attributes the disaster to a leak, resulting from a corroded battery lining and corroded rivets, and to the failure of the boat, through poor diving qualities, to respond promptly to a tilting of her rudder, which should have returned her to the surface. The "F-4" was a fairly new submarine, having been accepted by the Government on May 2, 1913.—EDITOR.

WHEN the "F-4" was finally located the day following her disappearance off Honolulu on March 25, it seemed at first hopeless to salvage her on account of the weight to be lifted and the difficulty of making lines fast at the great depth of three hundred feet.



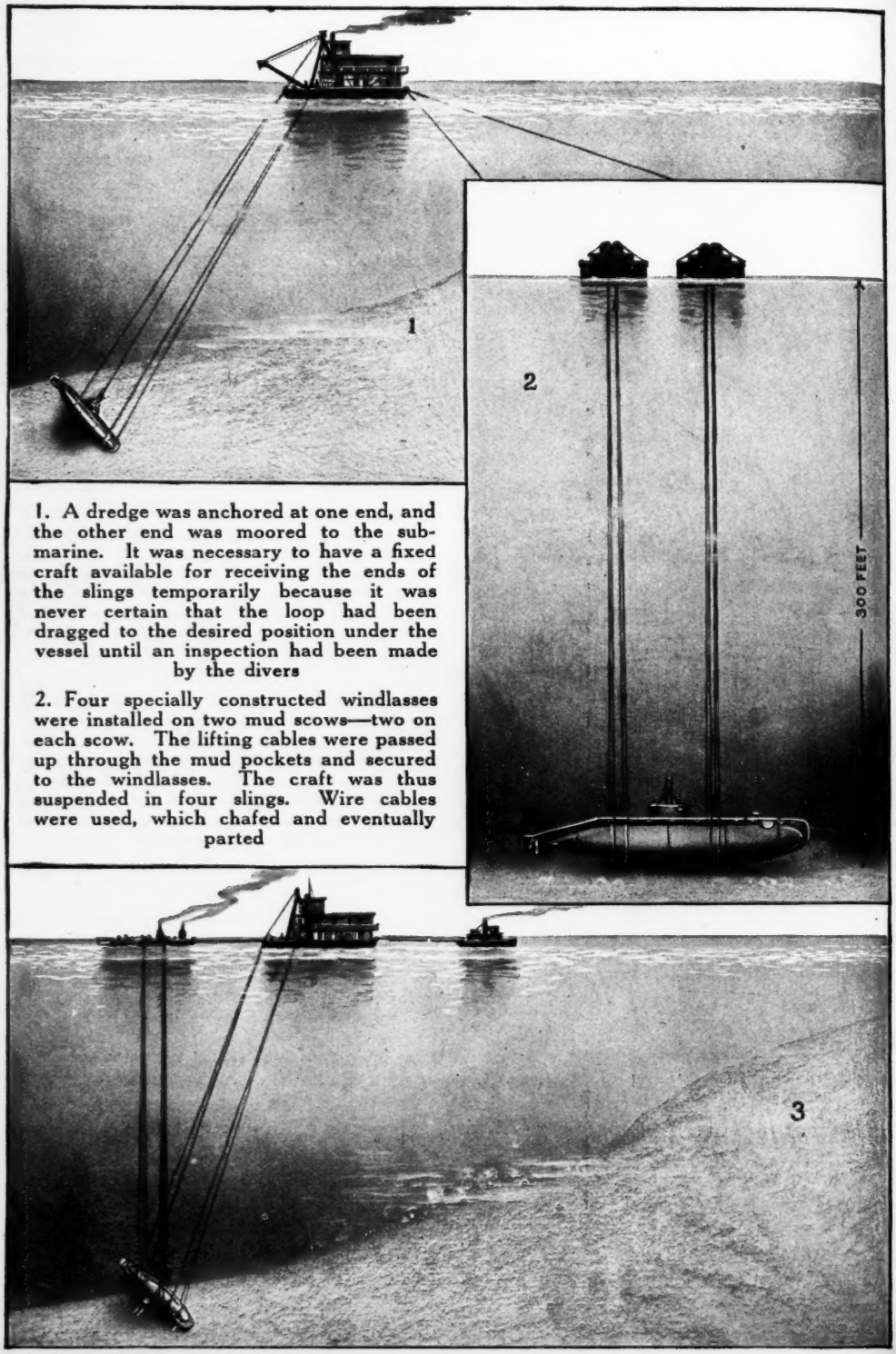
The four divers who did the under-water work in connection with placing the pontoons from August 21st to 29th. The work was extremely arduous. From left to right the men are: Chief Gunners' Mate Evans, Chief Gunner's Mate Agraz, Gunner's Mate O'Brien and Gunner's Mate McMillan. These are not the divers who went down to three hundred feet, as they had returned to New York in June

The most direct method of lightening a submerged vessel is to close the accidental apertures and to pump out enough water to make the craft buoyant. In the case of the "F-4" this method of attack was entirely out of the question, because of the great depth of water.

All submarines are equipped with an internal air salvage line, having an outboard connection for the purpose of blowing the vessel free of water in case of just such an accident as that which occurred. This provision did not solve the salvage problem in this instance. In order to displace the water from the vessel it would have been necessary to deliver air below at one hundred and thirty-five pounds pressure—a problem in itself, as the pressure at the compressors would have had to be maintained at about one hundred and sixty pounds to overcome the friction in the great length of small hose leading to the vessel. Besides air salvage was finally disqualified because, even under the most favorable circumstances, it would have relieved the vessel of only part of the water, and because the ballast tanks could not have been thus emptied.

Any plan devised for recovering the submarine, therefore, had to be based on the proposition of lifting two hundred and sixty tons of dead weight from a depth of three hundred feet under salving conditions probably unprecedented.

RAISING THE "F-4" FROM A DEPTH OF THREE HUNDRED FEET



1. A dredge was anchored at one end, and the other end was moored to the submarine. It was necessary to have a fixed craft available for receiving the ends of the slings temporarily because it was never certain that the loop had been dragged to the desired position under the vessel until an inspection had been made by the divers

2. Four specially constructed windlasses were installed on two mud scows—two on each scow. The lifting cables were passed up through the mud pockets and secured to the windlasses. The craft was thus suspended in four slings. Wire cables were used, which chafed and eventually parted

3. After the wire cables broke, it was decided to use chains. As the submarine was lifted, a towing strain was kept on the dredge by a tug

Why Pontoons Could Not Be Employed in the Early Stages

The buoyancy of pontoons is ordinarily used to float a wreck when the vessel itself cannot be given positive buoyancy. In such cases the lift to be accomplished is usually small—sometimes only a few feet, which, by taking advantage of the tide, may be sufficient to take the ship off the bottom. If a number of lifts must be made in order to bring the vessel up, the pontoons are sunk almost to the deck level at low tide. The lifting cables are then hove taut. As the tide rises the pontoons are also pumped out. When the vessel is clear of the bottom the pontoons, with their suspended load, are towed inshore at high tide until the vessel again grounds. Sinking the pontoons and taking in the slack of the chains is repeated at the next low tide. If there is much rise and fall of tide, a considerable lift may be accomplished at each step. In this manner the wreck is gradually worked into shoal water or even landed in drydock.

In the case of the "F-4" the conditions for pontoon lifting were not favorable. The difference between high and low water is only about one and one-half feet off Honolulu. As the vessel lay in three hundred feet of water, a great many lifts would have had to be made. For these reasons it was necessary to bring the submarine up by mechanical means.

Four specially constructed windlasses were installed on two bottom-dumping mud scows—two on each scow. The lifting cables were passed up through the mud pockets and secured to the windlasses. Instead of securing the cables to the vessel, the loops of the cables were swept under the submarine and both ends taken to the windlasses, thus suspending the craft in four slings—two at about one-third the length from the bow, and two about the same distance from the stern.

How the Slings Were Placed Under the "F-4"

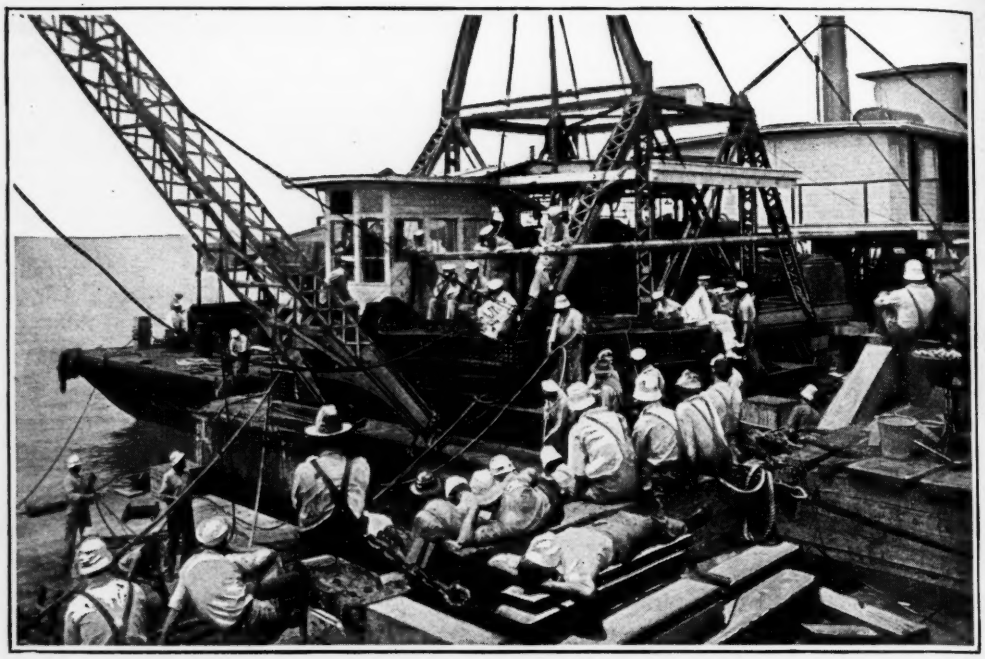
Placing the slings under the vessel was the most difficult feature of the salvage work. Four wire cables were used at first. A dredge from which the boom and bucket gear had been removed was used for the central unit of the salvage plant. This dredge was anchored at one end in the usual manner, as shown in the illustration. The other end was moored to the submarine by means of the lifting cables which were eventually transferred to the scows. It was necessary to have a fixed craft available for receiving the ends of the slings temporarily, because it was never certain that the loop had been dragged to the desired position under the vessel until an inspection had been made by the divers.

A New Record for Divers

The divers, while the vessel was in three hundred feet of water, set a new world's record for depth. The Bureau of Construction and Repair of the Navy Department had been experimenting for some time on deep-sea diving. It so happened that these experiments were brought to the point of practical application just before the accident to the "F-4." Four divers, in charge of the officer who had been conducting the experiments, were ordered from the New York Navy Yard to Honolulu as soon as it became apparent that the vessel could not be dragged into shallow water.

The diver does not wear a suit of special character when working in great depth as is the popular impression. The difference as compared to shallow water procedure lies entirely in the method of supplying air to the helmet and in the scientific restoration of the diver's body to the normal state by gradual decompression as he comes up from deep water. Air is supplied from flasks charged to a high pressure—suitably reduced before being delivered to the diver's helmet. The dangers in deep-sea diving are due principally to the absorption of nitrogen by the fluids of the body, on account of the high pressure to which the lung tissues are subjected and to the extreme exhaustion accompanying any kind of manual labor. For the latter reason the divers could not do heavy work at the three hundred-foot depth such as can easily be done by men working in shallow water.

After innumerable difficulties all four slings were swept under the vessel by means of tugs and the ends transferred



Dredge and scows used during the first phase of salvage work. Waiting for a diver to come up from 300 feet of water. In order to effect decompression gradually, the divers were sometimes two and a half hours in making the last one hundred feet back to the surface

from the dredge to the scow windlasses. This took from April 10 until April 21. On April 22 lifting the submarine by winding up the cables on the windlasses was started. As the cables were wound up, a towing strain was kept on the scows, thus bringing the submarine into shallower water.

One of the Lifting Cables Breaks

After lifting about twelve feet one of the cables parted in the loop, due to chafing on the bilge keels. This cable was one of the first to be placed, and had consequently suffered from chafing for almost two weeks, due to the continual motion of the dredge and of the scows in the swell. The broken sling was renewed and lifting was continued until the vessel was in two hundred and seventy-five feet of water. Bad weather now set in and accelerated the impairment of the cables, causing them to carry away one by one. It was now apparent that chain would have to be used for that portion of the slings in contact with the vessel.

The use of chain for the loop of the slings was considered when the salvage plan was first being developed, but was rejected, because chain does more damage to a vessel and is much harder to place than wire rope. These disadvantages had now to be accepted. A fifteen-fathom shot of two and five-eighth inch chain was accordingly shackled in to form a loop of each sling. The dredge was again moored as before by sweeping one and three-quarter inch wire lines under the bow and the stern of the submarine and bringing the ends to the corners of the dredge. The chain slings were finally placed in the same locations as had been occupied by the wire rope slings. Bringing these combination slings to position was considerably more difficult than placing the wire cables, because they were even heavier and more awkward to handle than the latter. After working twenty-one days, four slings were again in place under the vessel.

As the submarine was lifted a towing strain was kept on the dredge by a tug. This in turn brought a towing strain on the submarine. The arrangement proved more satisfactory than towing directly on the scows, because it permitted the scows

to ride in their normal state of equilibrium.

Once the slings had been made fast to the windlass drums, lifting was fairly rapid. After the windlass shafts had been filled with one layer of cable, it was necessary to cut off the wound-up portion and to shift to a new hold under the hook bolts. It was impossible to wind up a second layer, because of the enormous loads on the slings. One layer of cable corresponded to a lift of fifty-eight feet. The shafts could be filled in about two hours of actual lifting, but the work of cutting off and shifting to a new hold took considerably longer.

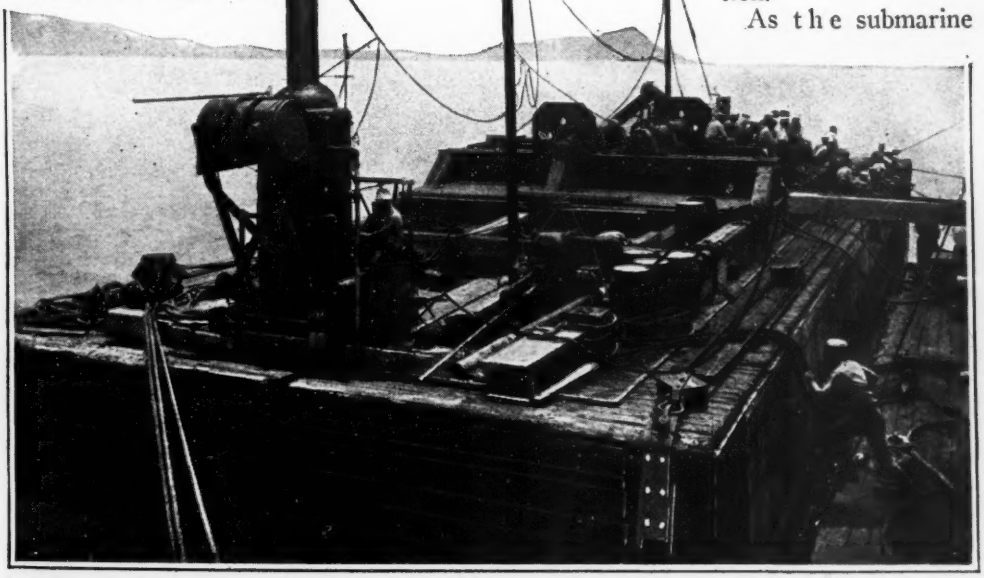
In spite of every effort one of the stern lifting slings could not be located quite as far aft as desired when it was put on, consequently it did not plumb the mud pocket through which it passed. This was immaterial in deep water, but as shallower water was reached, the sling began to bind on the framing of the pocket. When a depth of fifty feet was reached, it became necessary to shift the sling to a more vertical position.

A Storm Rises and the Submarine is Dropped for Safety

While this work was going on a heavy ground swell set in very suddenly. The swell increased rapidly and in a short time high surf waves were breaking near the submarine. The waves and the undertow from the reef caused the scows to charge back and forth with tremendous momentum. The after sling could not now be replaced in time to resume operations. It was apparent that considerable damage would be done to the submarine by the slings and that possibly the entire plant would be wrecked if an attempt were made to ride out the bad weather. The slings were accordingly cast off and the scows towed into the harbor.

The heavy seas continued for a number of days. As soon as the swell had subsided sufficiently, divers were sent down to examine the submarine. They reported that the forward slings had ruptured the shell and had caused the collapse of some of the framing one-third of the distance from the bow. This made it unsafe to continue operations by the windlass method, as there was danger of breaking off the forward end of the vessel while passing through the channel. This would have blocked the harbor to navigation.

As the submarine



End view of a lifting scow. Operations are suspended waiting for a diver to come up. Note the heavy purchase in the right foreground, leading to the hoisting engine for turning the windlass

now lay in somewhat less than fifty feet of water, it was possible to apply the pontoon method of lifting, but it was still impracticable to follow the orthodox procedure of lifting a few feet and towing to a new landing, because conditions were such that the vessel had to be raised in one operation to a draft of not more than twenty-five feet. This draft was fixed by the depth of water over the blocks of the drydock in which the vessel had to be landed.

To meet these requirements six specially designed pontoon cylinders were sunk alongside of the submarine, as shown in the illustration. The plan further called for the use of six chains rove under the vessel and passing through hawse pipes in the cylinders. The arrangement consisted in effect of a lifting of the submarine in a cradle made up of six chains.

The combined lifting capacity of the six pontoons was four hundred and twenty tons. A margin of one hundred and sixty tons was allowed for breaking the vessel away from the bottom and for any railure to utilize all of the buoyancy available in the pontoons.

Carrying the Submarine into Port on Pontoons

The chains were first of all worked under the submarine in predetermined positions, two forward, two amidships and two aft. The two chains of a pair were spaced sixteen feet apart so as to correspond to the distance between the hawse pipes. The pontoons were planted by means of a wrecking scow which was moored accurately over the submarine. The two cylinders of a pair were towed to the scene of operations and placed one on each side of the scow, directly over a pair of chains lying on the bottom as shown in the illustration.

The ends of the chains were now fished up through the hawse pipes and the cylinders submerged by opening the flood valves. They were kept under control while sinking by means of five-inch manila lines made fast to the ends and taken to the hoisting engines on the scow. The process consisted, therefore, in threading the pontoons onto the chains. After the pontoons had landed on the bottom the chains were adjusted so as to leave the necessary amount of slack to permit the pontoons to rise just clear of the vessel on becoming buoyant. A clamp was now fitted to each chain by the divers, just above the hawse pipe. The clamps consisted of two steel castings, moulded to the shape of the chain links and of such length that they spanned the hawse pipes. By means of four heavy bolts the two halves of the clamp were drawn together. These bolts kept the clamps from spreading and the chain from slipping through when subjected to the lifting strain.

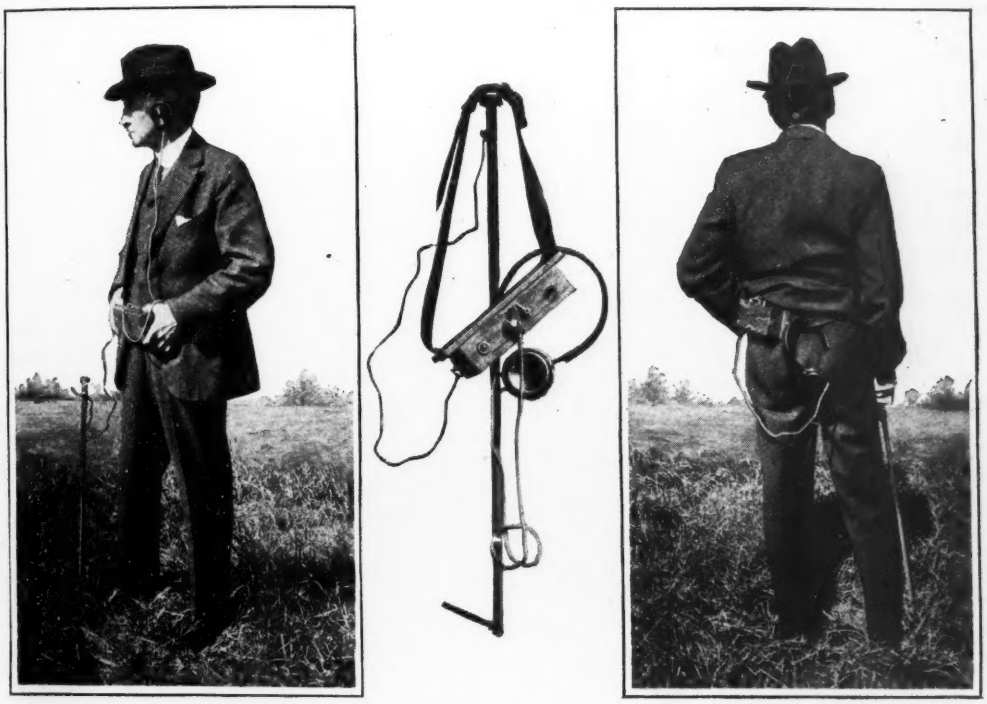
After all six cylinders had been landed on the bottom alongside of the vessel and the clamps had been secured by the divers, the unwatering process was started. For this purpose torpedo air flasks, charged to a pressure of two thousand one hundred and fifty pounds were placed on a coal barge. The flasks were piped to an expansion chamber which in turn was connected to a manifold. Twelve three-quarter-inch air hose lines were led from the manifold valves to the blowout valves on top of the pontoons. A pressure of thirty-five pounds was used at the manifold for blowing out the water while the cylinders were resting on the bottom. The unwatering operation had to be watched very carefully so as to avoid the danger of springing the heads of the cylinders when the external water pressure was relieved on emerging.

The method proved successful in every detail. The work of placing the chains under the submarine was started on August 21. All of the chains were in position on August 25. It then took one day to place each pair of cylinders. This could be done only during daylight, as the divers could naturally not work in the dark. On August 29 everything was ready for blowing the water out of the pontoons. This operation took about two hours from the time the air was fully turned on. One end of the submarine came up slightly ahead of the other, as was to be expected. The vessel was towed into the harbor suspended from the six pontoons as shown in the illustration, and was docked the following day.

Another Pocket Wireless

SINCE the beginning of the European war, many compact, light wireless receivers have been proposed for military use. It is not at all difficult to build a tiny apparatus, which may be carried about, concealed in one's clothing, yet which will receive "radio" messages from nearby powerful wireless stations. In this way, if a good electrical connection to earth can be made by way of a metal staff forced into damp earth, signals may be heard several miles. If, in addition, considering the liability of electric shock from the instruments, to carry enough batteries for sending messages even a mile or two would be more than any ordinary man would care to attempt. A small sender can be built, however, strong enough to send signals a few hundred feet, yet compact and light enough for a person to carry.

Dr. H. Barringer Cox, of Bedford Hills, New York, has devised and built an interesting set of such portable appa-



With his pocket wireless aparatus attached to his body, Dr. Cox, the inventor, becomes a veritable radio station

an umbrella is used to hide an "antenna" wire for absorbing the energy of the passing wireless waves, still greater distances can be covered. All of this has been done many times, and, in fact, small instruments for the secret reception of wireless messages have been on sale in various European cities for several years.

To build a similarly portable wireless sender is a very much more difficult thing, however, because considerable power is necessary if messages are to be transmitted more than a few yards. Without

ratus. The photographs herewith show the receiver and the way in which it can be hidden from view by strapping it underneath the operator's coat. The heavy staff is used to connect with the earth; a wire run inside the trouser leg and connecting to a heel-plate can be made use of when the stick proves inconvenient. Dr. Cox's sender and receiver may both be worn on a single belt; and two men thus doubly equipped would be able to communicate secretly.

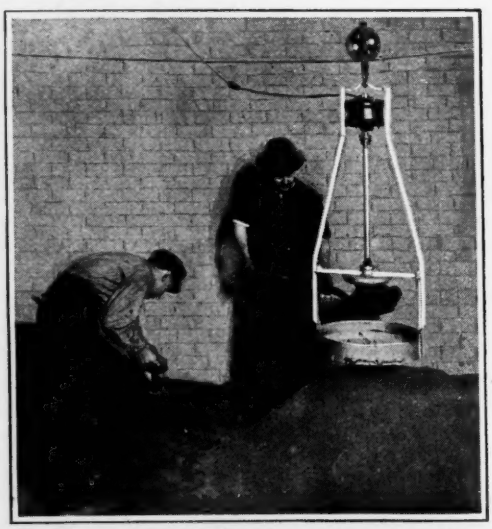
Demonstrations have been followed

with considerable interest. In one test a small sender consisting of a vibrator, operated by five dry cells, was connected to an automatic Morse transmitter and left to radiate its messages throughout the neighborhood. The receiver was then strapped on, and it was found that the signals could be heard quite distinctly some distance from the sender. When the transmitter was connected to a water-pipe as well as a bare vertical "aerial" wire, greater space could be covered. Similarly, when the receiver was lifted higher from the ground, the received signals were intensified.

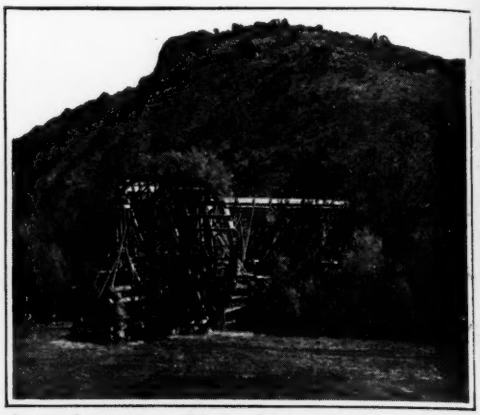
Dr. Cox uses in his apparatus a specially built transmitter, the construction and operation of which he will not discuss. Aside from this, however, the entire set of instruments is believed to be quite similar to those developed by others. Some further improvements are being made, and it is thought that this latest "walking wireless" may find use in the present great war.

Electricity Sifts Sand

The old-time sand sifters of our youth have been relegated to the scrap heap. Today in the modern foundry, and other places where screening of sand is a necessity, electrically operated riddles, or sieves, are installed. These sifters of sand work without interruption and do the work of ten men.



This electric sand sifter does the work of ten men



A crude water wheel which makes the river pump its own water to irrigate a California farm

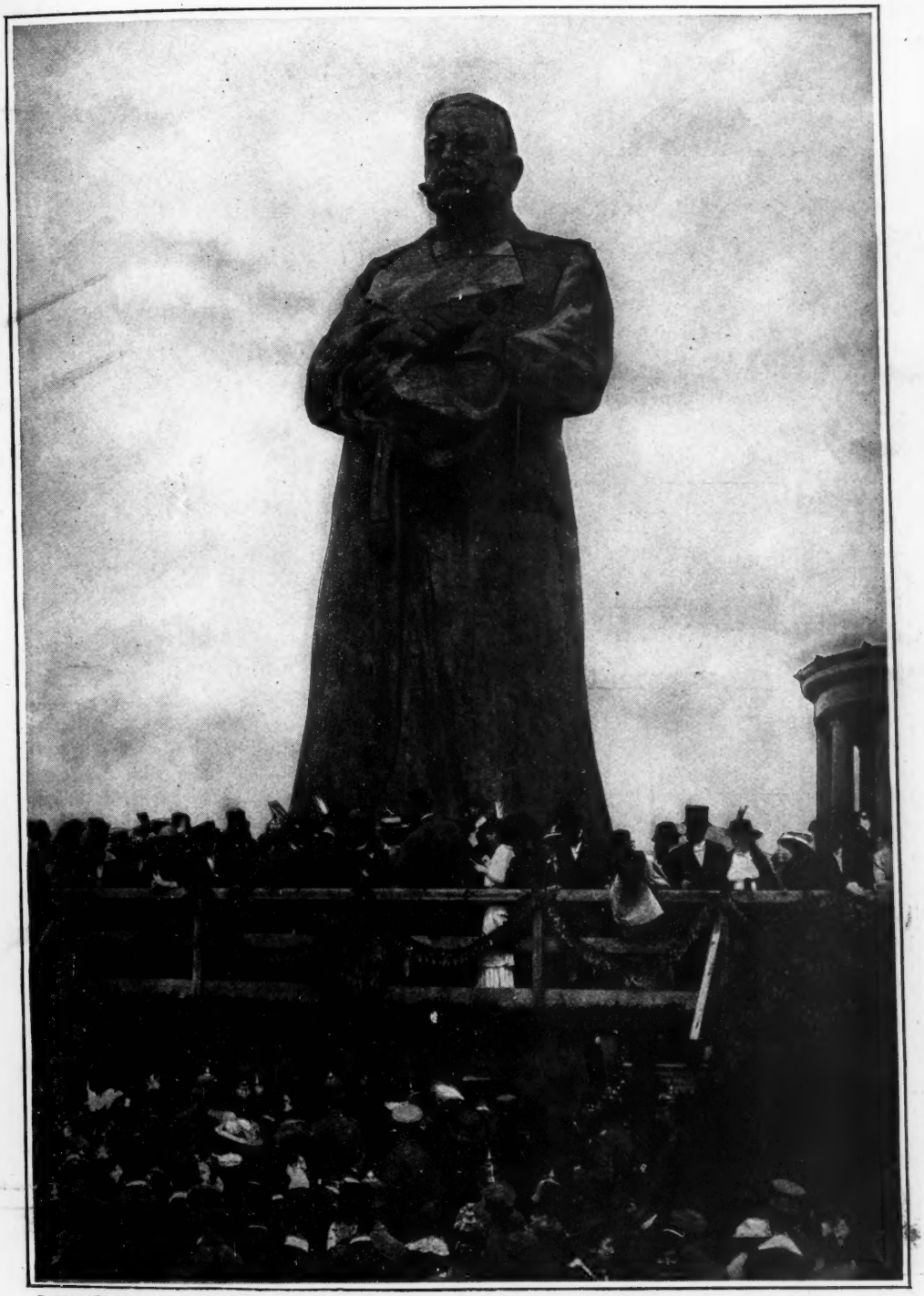
The electric riddle requires but one-sixteenth horse power to drive it and the apparatus can be run on a trolley along a line of twenty moulders, supplying perfectly clean sand as fast as it is poured into its receiving pan.

A River Which Pumps Its Water

In a number of sections of northern California there are vast tracts of land which are watered only by irrigation and where the government has not yet carried out any reclamation projects, even on the smallest scale. The settlers and ranchers have improvised irrigation facilities of their own. These appliances, though crude and original, are none the less effective. Some of the best are used by the ranchers of the narrow winding valley of Klamath river.

Numbers of large irrigating wheels, operated by the river current, are in operation here. These are about eighty feet in diameter, built of wood and strongly braced to withstand the current. At short intervals are placed "flood boards," on cross-paddles, which, when immersed in the water, cause the wheel to revolve as the current strikes them. Attached to the outer rim, on each side, at short distances, are large box-like metal buckets, which are successively filled, hoisted and emptied into wooden flumes. Thence the water flows in side flumes into deep ditches dug along the high banks of the river. Many of these ditches are miles in length, and the water is distributed for leagues.

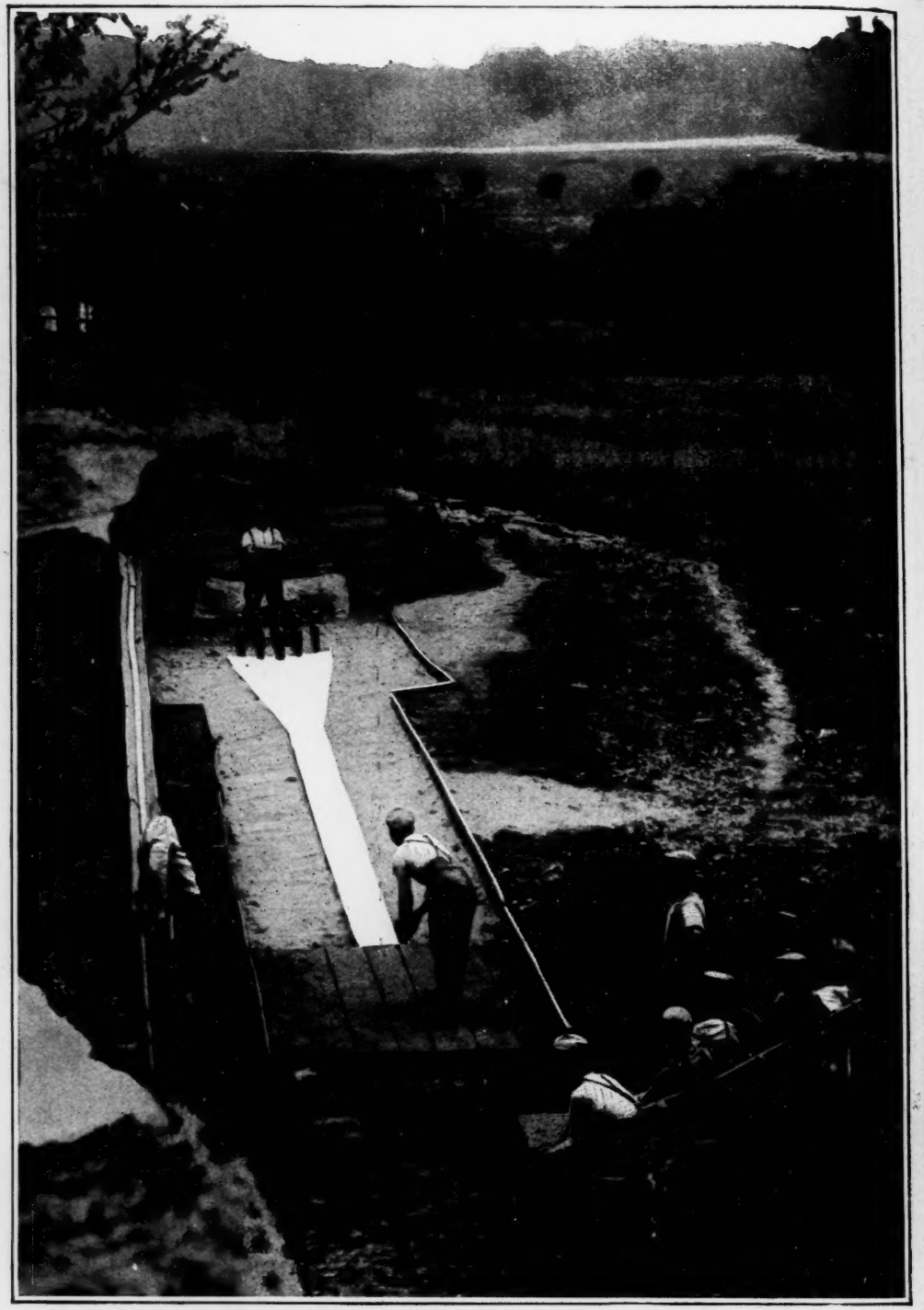
VON HINDENBURG IN WOOD AND NAILS



Courtesy London Illustrated News.

This great wooden statue of Field-Marshal von Hindenburg has been recently unveiled in Berlin. Patriotic Germans drove nails into this, at five marks per iron nail, ten marks for a silver nail, and as much over that as they wished to pay for a gold nail.

BOWLING BEHIND THE GERMAN TRENCHES



German soldiers bowling during a period of rest behind the firing line. Each of the warring armies allows its soldiers a regular rest every few days. Other troops take their places in the trenches, and those who have been relieved retire a short distance and are free to amuse themselves as they wish

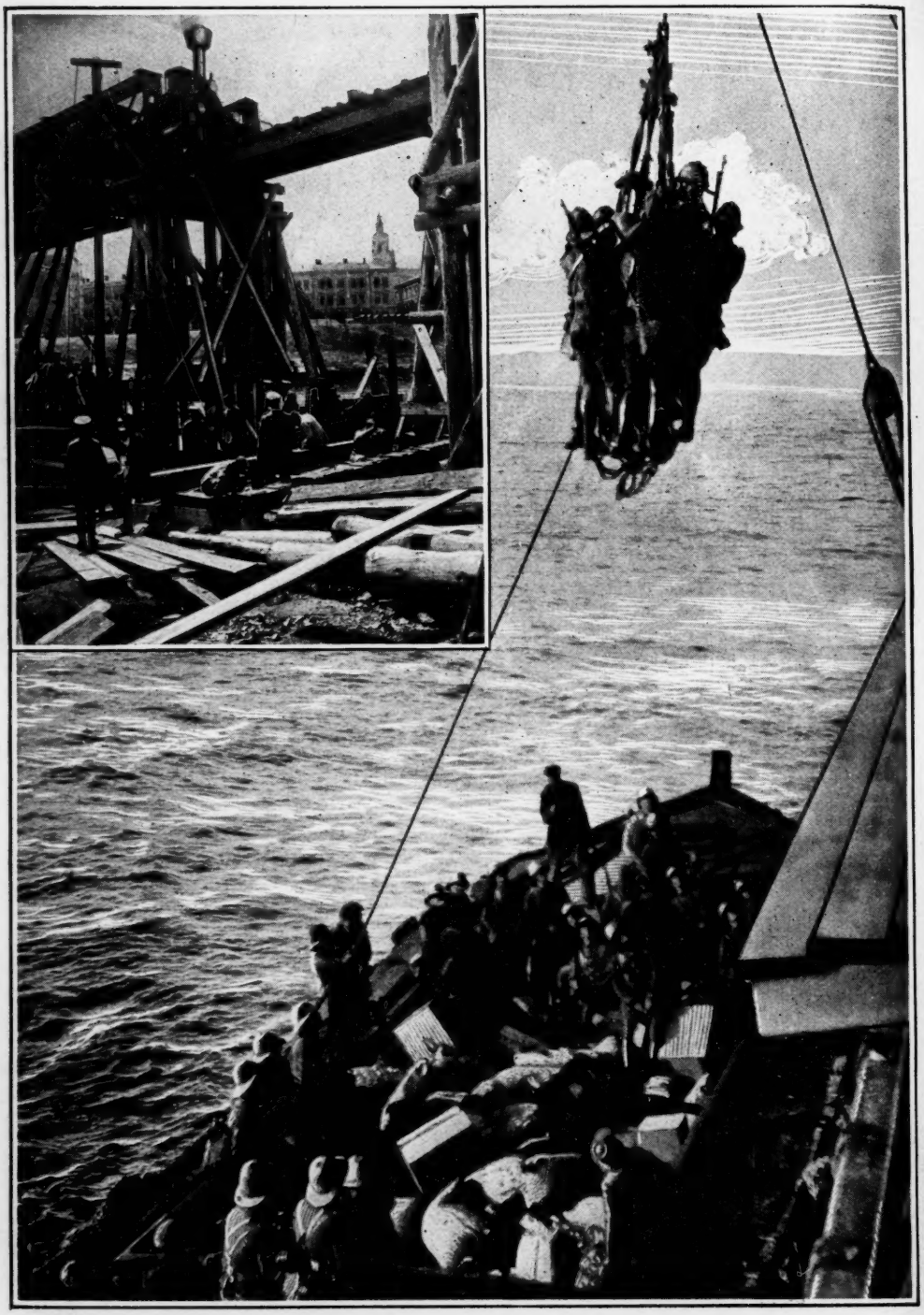
NOT MARTIANS, BUT EARTHLY SOLDIERS

© International Film Service.

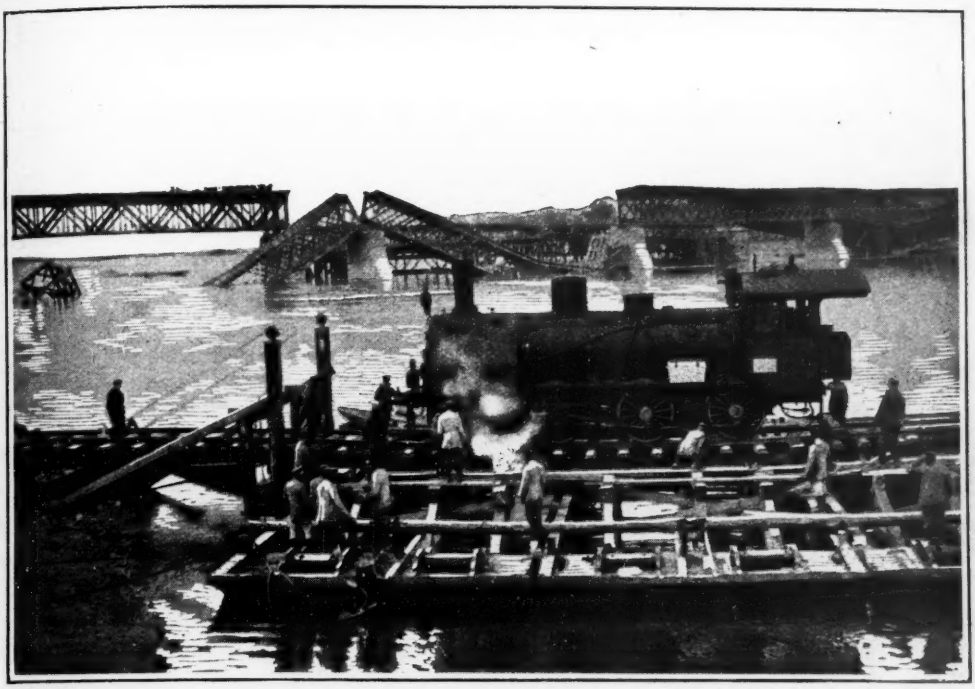
A detail of French infantrymen awaiting an attack in a ruined town in the Champagne district. In these regions attacks are usually preceded by a cloud of gas, and all soldiers are equipped with the latest form of respirators.

© Underwood & Underwood.

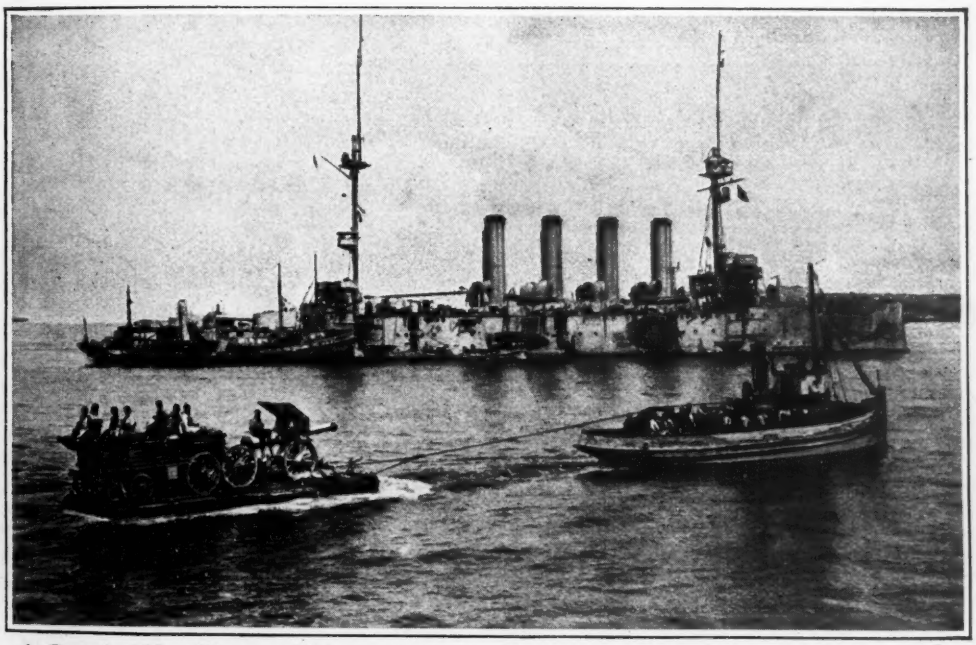
A French regimental band practicing in the gas-suffused ruins of a small village in the Argonne district. In order to protect themselves against the gas, the entire band is wearing the new hoods, which completely cover the head. When their regiment is in the trenches, the bandsmen act as stretcher bearers, and the casualties are heavy



British troops disembarking from a transport at the Dardanelles. Great barges are used to carry the troops and their provisions and equipment to the shore. (Above) Germans reconstructing a railroad bridge which had been destroyed by the Russians during the recent German drive through Russian-Poland



German engineers preparing to ferry a locomotive across the Vistula River. In the background is the Warsaw-Praga bridge, destroyed by the retreating Russians. When this photograph was taken the Germans were already repairing the bridge, while locomotives and cars were ferried across the river on pontoons



A French 155-millimeter field gun being towed ashore on a lighter near Sedd-Ul Bahr. In Gallipoli, advances have been made by slow trench-to-trench warfare. A large number of guns are needed to break down the enemy's wire entanglements before starting an attack

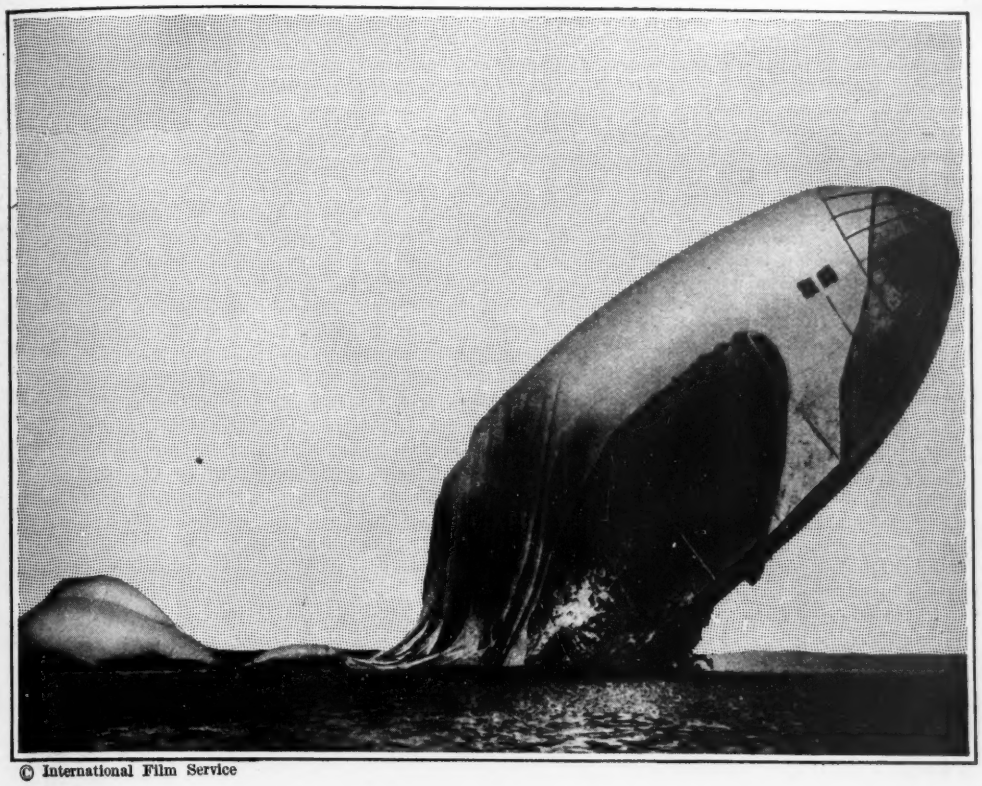
INFLATING A BALLOON WITH HYDROGEN

Engineers of the French Flying Corps inflating an observation balloon. The gas for these balloons is stored under great pressure in long steel bottles, and may be easily transported from one section of the line to another. A pile of these bottles is visible on the left. In Germany these bottles are filled with waste hydrogen from the chemical works

Courtesy Illustrated War News

This picture continued on opposite page.

Allied airmen have recently been baffled by a new German strategy which emulates the octopus and the naval use of smoke-screens. The German aviator carries, in addition to bombs, a number of smoke balls. When in danger of being overtaken by a speedier aeroplane equipped with a machine gun, the German throws out a lighted smoke bomb



© International Film Service

Although the French and English have a number of airships, they have been used very little during the present war. The Italians, however, have used their semi-rigid dirigibles to a considerable extent since their entrance into the general conflict. The illustration shows an Italian dirigible, the "Cita di Tesi," wrecked by Austrian shells in the sea off Pola

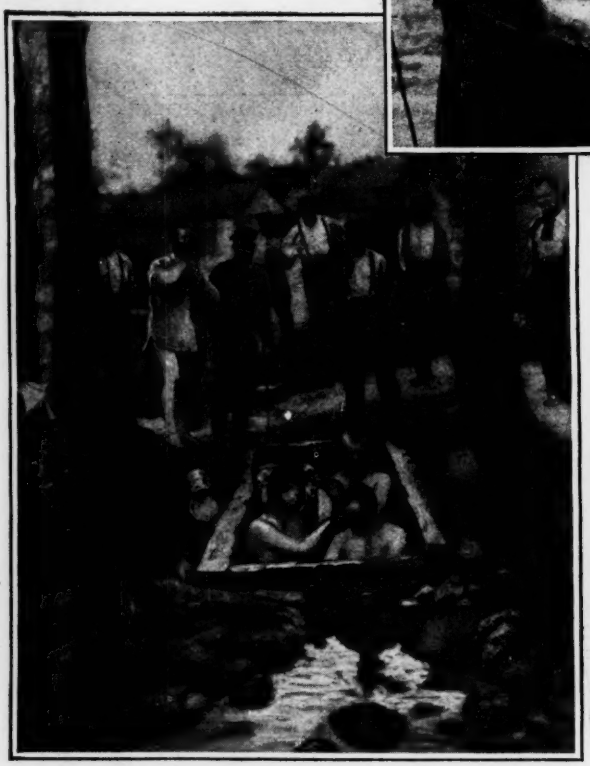
This picture continued from opposite page.

This develops a great cloud of dense black smoke. He then wheels and flies at an angle. The enemy is unable to fire at random for fear of wasting his precious cartridges, and by the time he has emerged into clear air the enemy is seen flying in another direction, ready to conceal himself again

BATHING UNDER DIFFICUTIES

British sailors "tubbing" on the deck of a submarine. War or no war, the English must have their daily tub. Sheets of canvas are stretched on the life lines. Water is supplied by means of a rubber hose. Although the apparatus is crude, it serves its purpose very effectively. The use of canvas bathing pools at sea is far from new. In times of peace warships let down tarpaulins supported on booms at the sides of the vessel and the sailors enjoy a sea bath without the dangers of deep-sea bathing. Even ocean liners used to introduce this as a novelty on trans-Atlantic trips, and the passengers always enjoyed the antics of the bathers, watching from the rail as the "greyhounds" of the sea sped on their way—and often passengers joined with the sailors in the refreshing "tub." Folding canvas "sponge tubs" are part of the equipment of particular English travelers

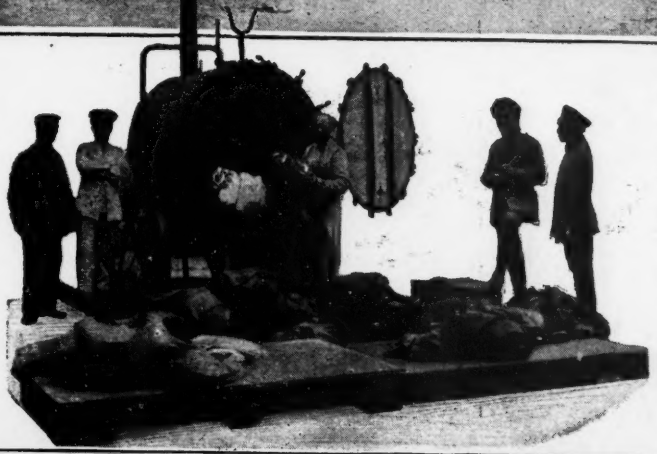
British sailors bathing in the North Sea and testing life rafts at the same time. This life raft is carried flat on the deck and if the ship sinks, floats free, with all on board



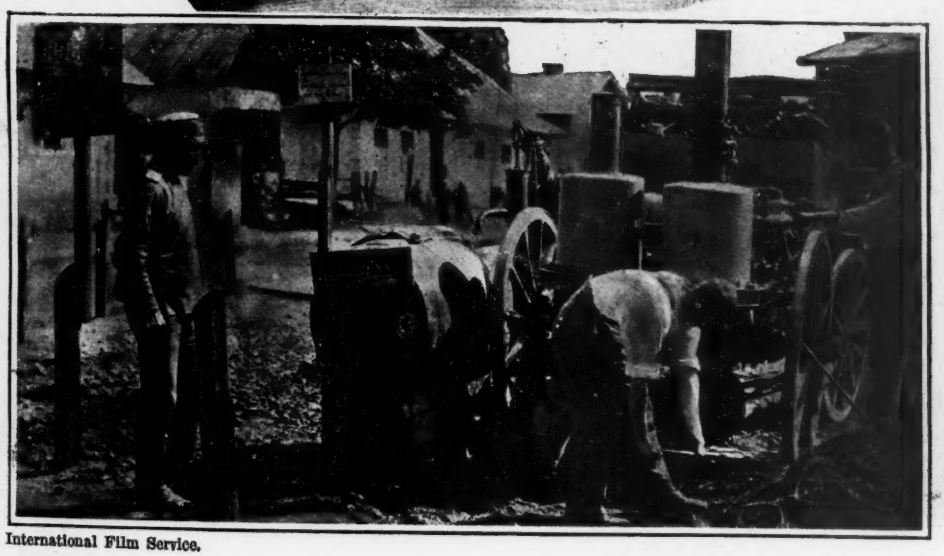
A rough tub in Russian Poland. This crude trough is sunk in the bed of a small stream of running water, and the sides are retained by logs. German soldiers are waiting their turn to take a bath on their day off from the trenches

DISEASE IS MORE DANGEROUS THAN BULLETS

Egypt is caring for her thousands of wounded in beds made of palm leaves. Above is shown a wagon train of these on the way to Cairo

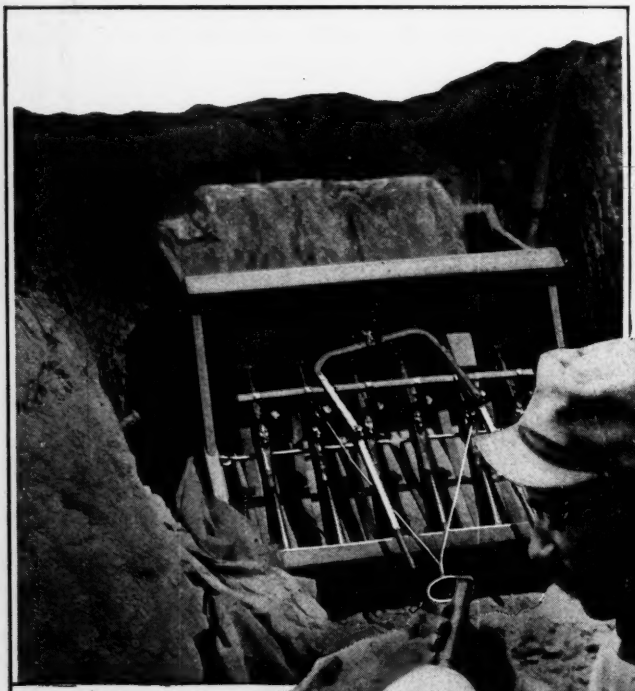


This is not a giant searchlight, but a mobile disinfecting plant for clothing. The apparatus is a vital necessity in vermin-ridden Galicia and Russia



© International Film Service.

Austro-German troops are forbidden to drink water from wells and springs not tested by medical officers. The illustration shows a water distilling plant belonging to the Austrians

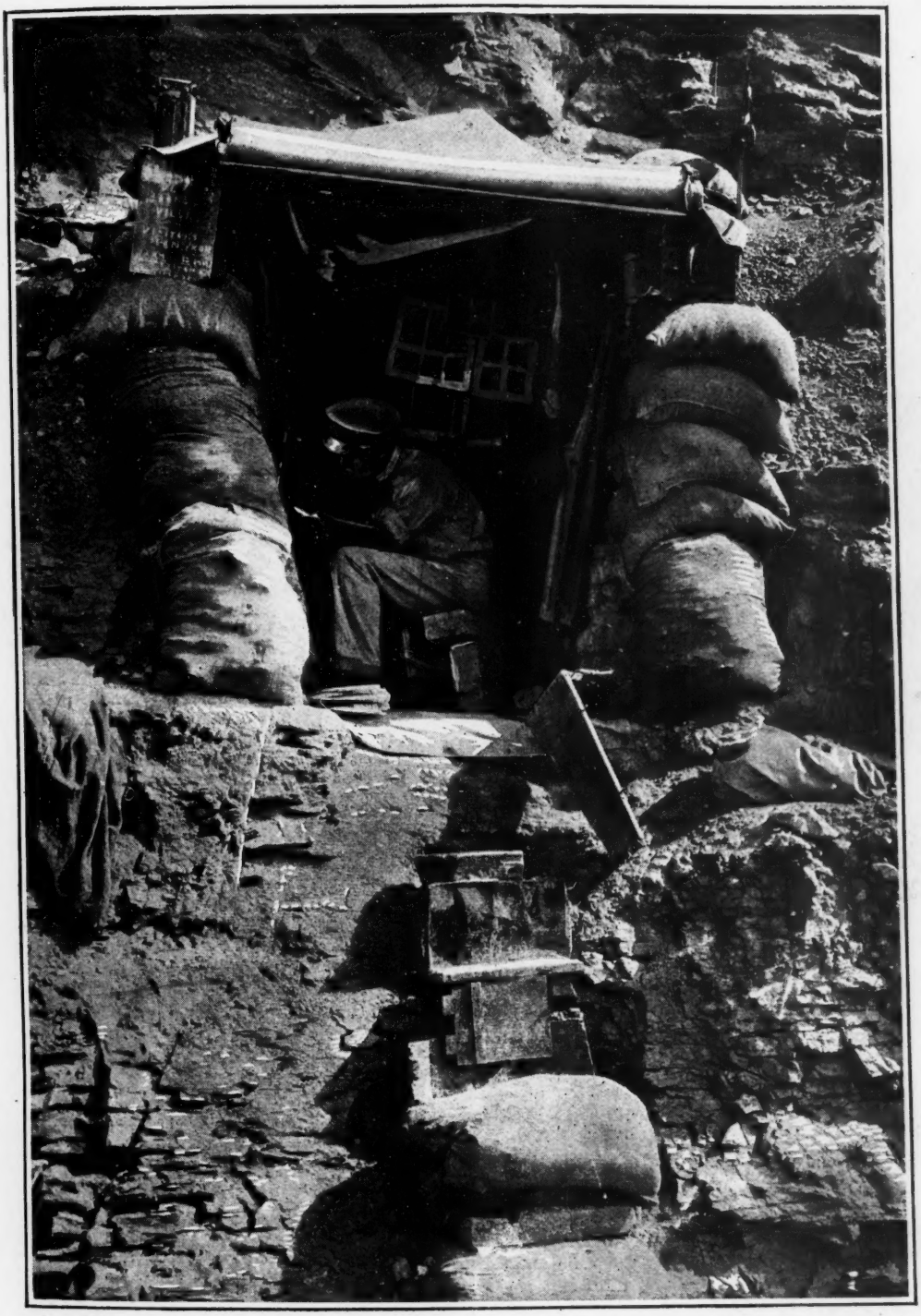


A clever French method of quick-firing when a machine gun is lacking. A half dozen ordinary rifles are put together in a box, and by means of a rod connection every rifle may be fired at the same time. Considerable speed may be developed by this method, as the more quickly the wire is pulled, the more quickly the shots are fired. This invention is defective. When the device has been fired five times the clips are all emptied and the guns must be loaded, with consequent loss of time, perhaps at a moment when time is the most precious of commodities

© American Press Association.

A bomb-throwing cannon in the French trenches. The tiny cannon throws the bomb, filled with high-explosive powder, into the opposing lines. The wings attached to the bomb impart a whirling movement to the projectile, and keep it on a true course, so that the percussion cap on the tip is certain to strike the ground, thus setting off the charge

WRITING HOME FROM A DUGOUT



The battlefields of the Gallipoli peninsula will probably furnish pages of history unequalled for blood and horror by any known before. Part of that history is being written today from the dugouts and bomb-proofs of the Allied lines, where British soldiers from the shores of all the seven seas gain their only respite from their battles with the Turk

INGENIOUS EXPEDIENTS IN FIGHTING

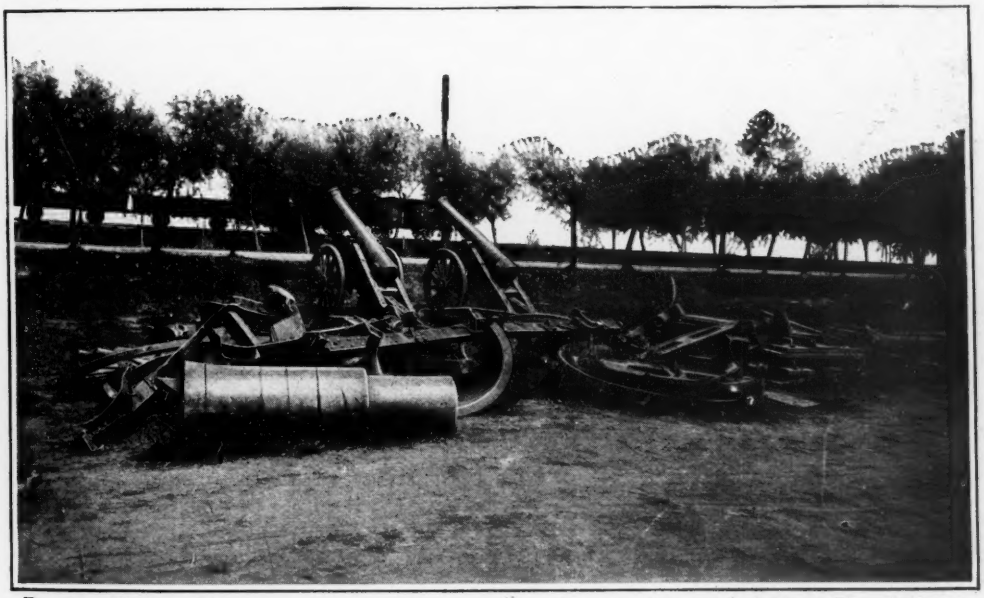
A machine-gun adapted by the Germans for anti-aircraft work. It is held in a special support, so that one man feeds cartridges, another pulls the trigger, and operated by three men, as here shown. Great accuracy can hardly be obtained with this weapon

French artillerymen lowering ammunition in the Vosges Mountains. This ammunition is carried from the motor trucks to the firing line in artillery limbers. In the rugged Vosges it is often found necessary to slide the shells down the sides of the mountains, as shown here, while the difficulties of transporting guns tax the ingenuity of the artillerymen and engineers. Small pieces and machine guns are carried over the mountains strapped to the backs of mules, while the larger field artillery is lowered down the mountains on skids

© International Film Service.

An ingenious mounting for a French mitrailleuse, or rapid-fire gun. By mounting the gun on a cart-wheel, with a barrel filled with stones for a base, this improvised anti-aircraft gun may be easily swung to follow the flight of aeroplanes, however fast they may go

The explosion of a German 150-millimeter shell near a French 155-millimeter rapid-fire gun. Only one member of the French gun crew has remained at his post, for the gun has been charged and sighted and needs only to be fired, which may be done by one man. The rest are in the bomb-proof under the bushes

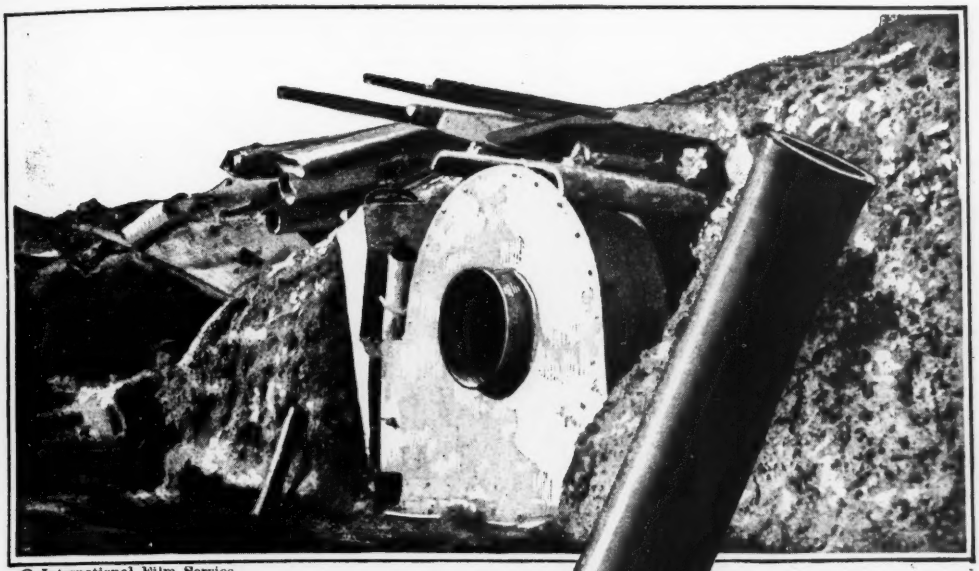


Russian 30.5 centimeter guns were broken like glass by German shells. The delicate breech mechanism may be easily destroyed by a shell which explodes near the guns, but in order to wreck a heavy gun as completely as are those shown in the illustration, it is necessary to hit the gun squarely with a projectile of heavy calibre

THE THORNY SIDE OF VICTORY

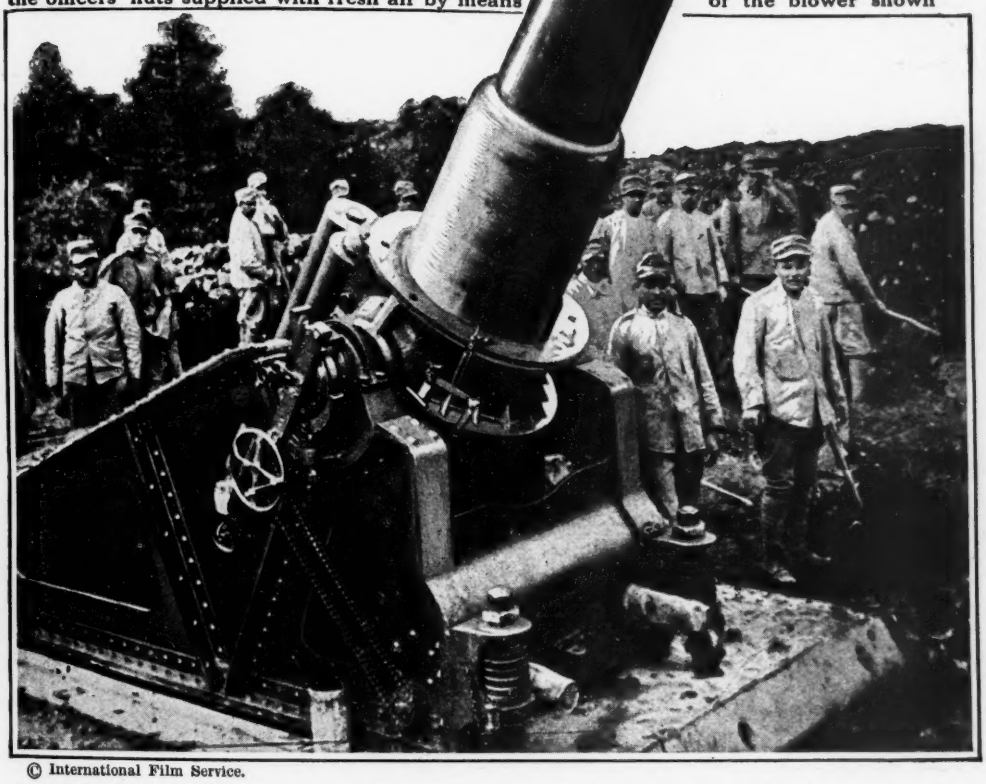
Photos © Brown & Dawson

The roads through the battle-scarred districts of Russian Poland are full of these Austrian entanglements, invariably erected after a victory, to act as a check against counter-attacks. (Below) Austrians erecting a barricade in a forest. The soldiers are seen hewing the limbs of trees into fence posts and barriers, across which the barbed wire is stretched



© International Film Service.

A ventilator in a German trench. So we see that even the ventilating engineer is used in war. When the French captured this trench they found the officers' huts supplied with fresh air by means of the blower shown

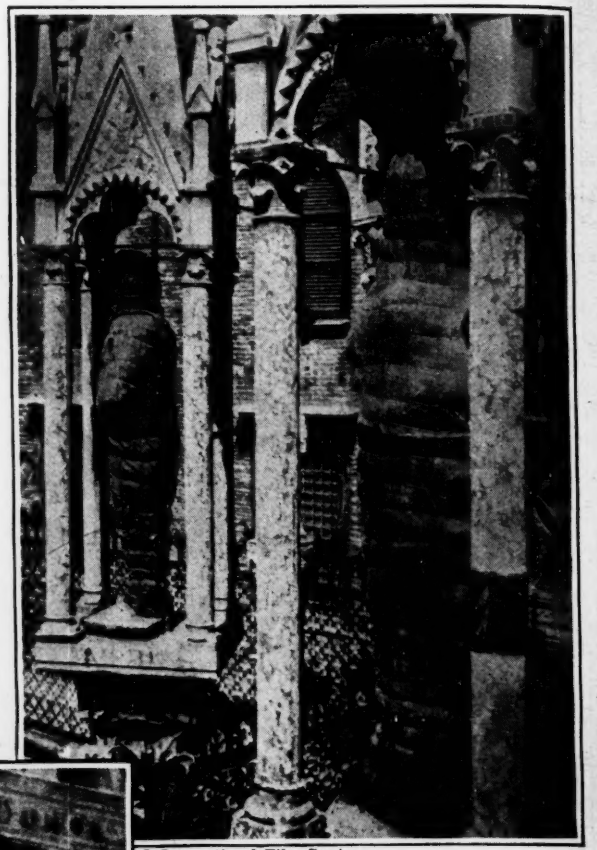


© International Film Service.

One of the enormous guns used in the war. A twelve-inch Italian howitzer near the Austrian front. These great guns must be supported by concrete—real civil engineering work. The transportation of such a "field piece" to its position was in itself a work which an old-time army quartermaster could hardly have handled

ITALY ARMORS HER STATUES AGAINST AIRCRAFT

The priceless statues and monuments of Venice have been encased in a heavy overcoat of plaster, surrounded with canvas, in order to protect them against injury by Austrian aeroplane attacks. The shells of the Italian anti-aircraft guns often fall in the cities which they are defending, and constitute nearly as grave a danger as do the bombs thrown by the enemy. The stairway of the ducal palace is an arsenal—of sand bags! That these precautions were well timed was demonstrated the latter part of October, when Austrian aeroplanes visited Venice and showered bombs upon the city. One bomb fell in the piazetta in front of St. Mark's, not far from these very mummy-statues. The damage which they might have suffered can be guessed when their age is considered, and one remembers that the Campanille crumbled to dust one fine day a few years ago, with not even a gentle Italian earthquake to start its disintegration. These statues are very old, and concussion nearby might well be as disastrous as a shell exploding on their heads.



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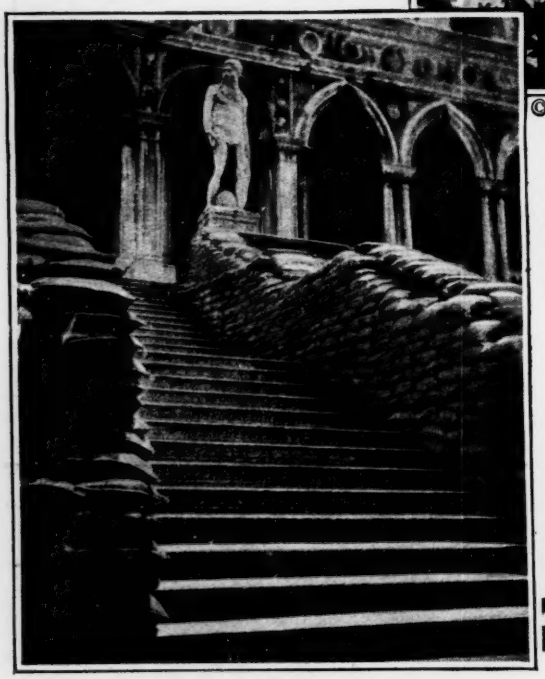


The horses of St. Mark's have been taken from their historic pedestal and have taken their way to underground caverns where they, at least, will be safe from attack, even though the city and St. Mark's itself shall fall

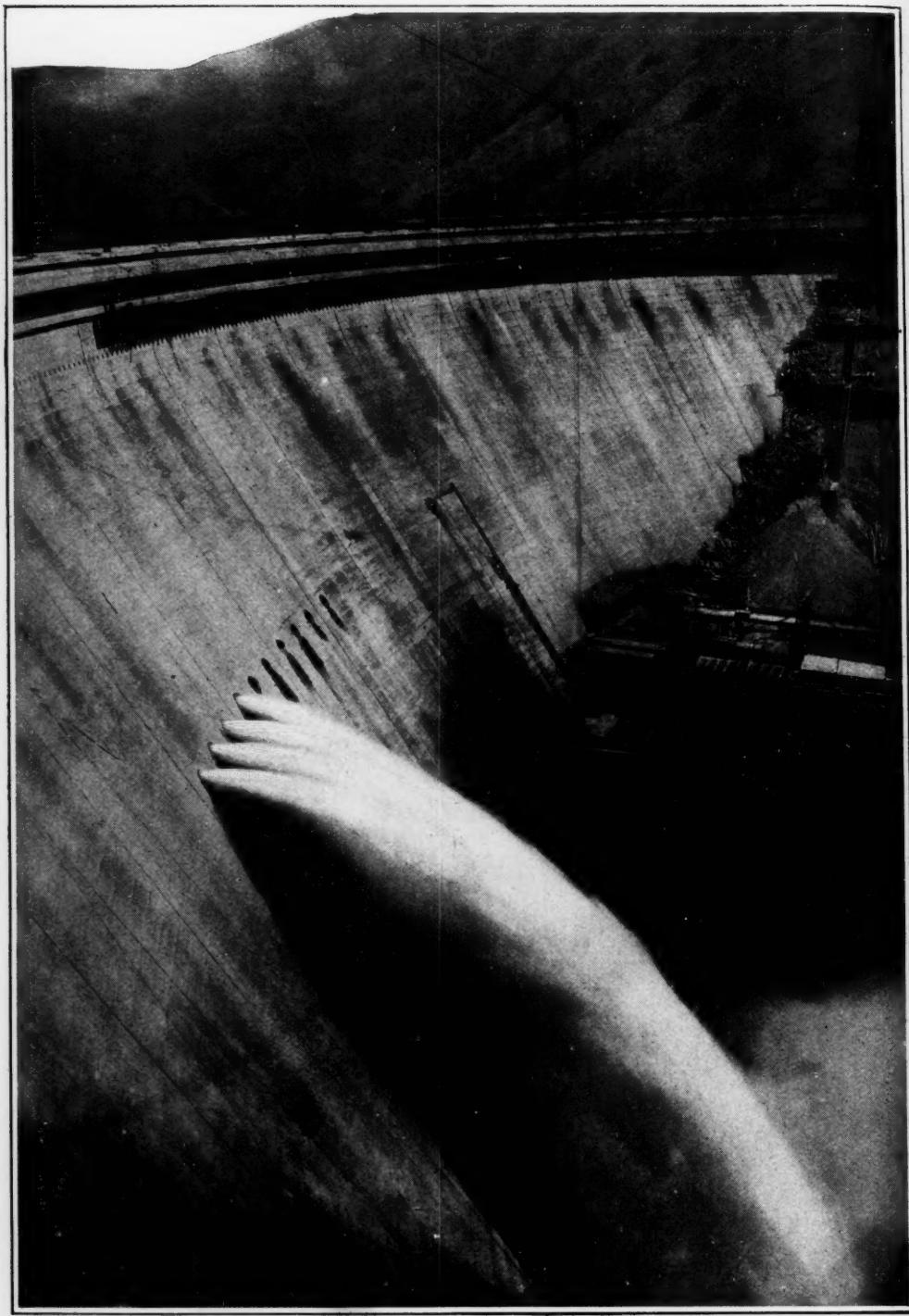
The statuary of St. Mark's has all been removed or else swathed in plaster and many coats of canvas. Gentle precautions, these, against modern explosives, but they would save the statues from destruction by concussion from explosions

THE EARS OF PARIS LISTENING FOR AIRCRAFT

By Courtesy of Illustrated London News

The most interesting of the special instruments employed for the defense of Paris against aerial attack are the "listening posts," one of which is shown in the illustration. This consists of four huge horns, which gather up the slightest sound and magnify it by means of a microphone, so that it is impossible for an aeroplane to approach unheard. The horns resemble reversed megaphones

THE HIGHEST DAM IN THE WORLD

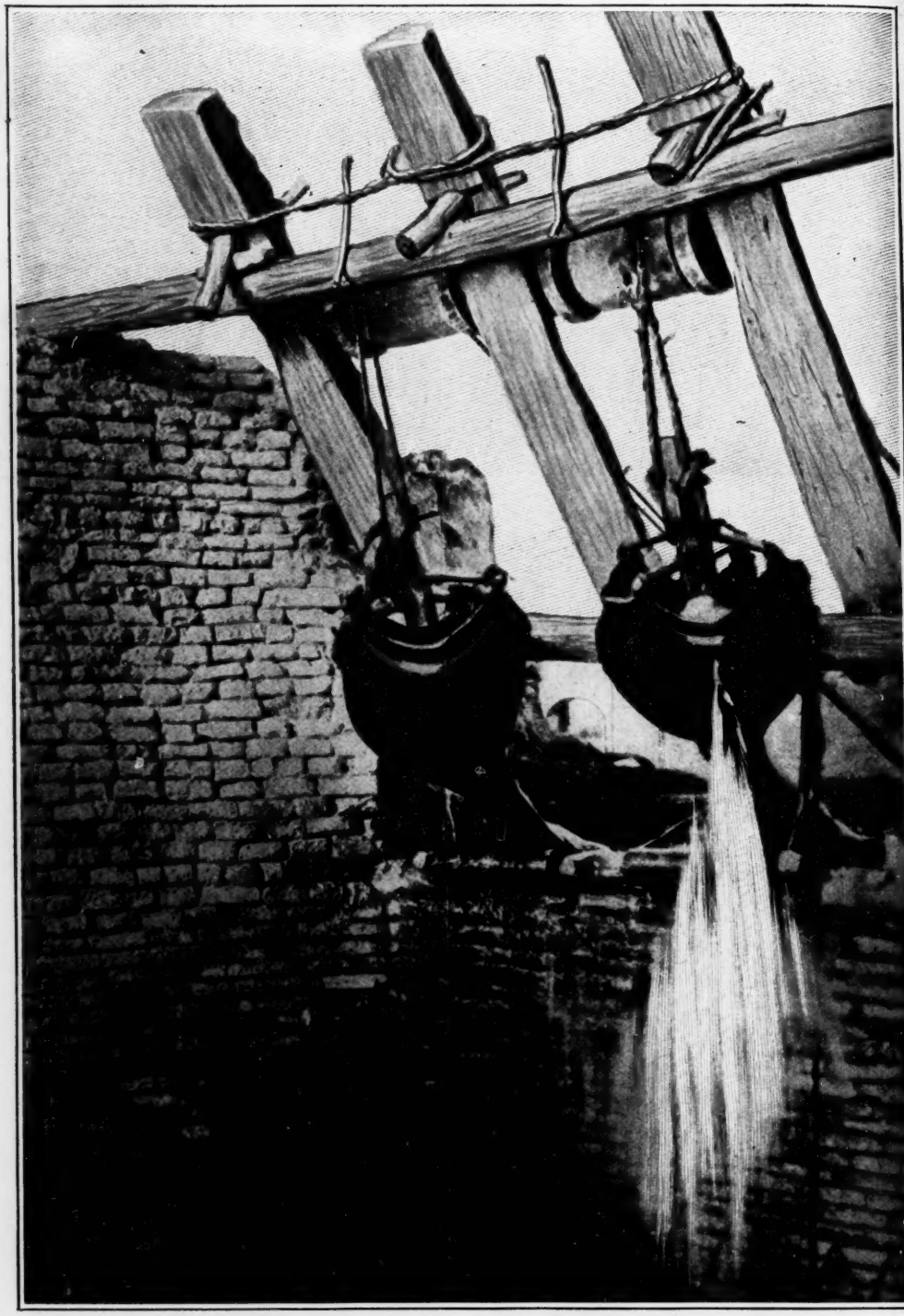


The great Arrowrock Dam, the highest structure of its kind in the world, was recently added to the completed projects of the Reclamation Service. This great irrigation project covers an area of two hundred and forty-three thousand acres, not far from Boise, Idaho. The dam is two hundred and sixty-one feet high, eleven hundred feet long.

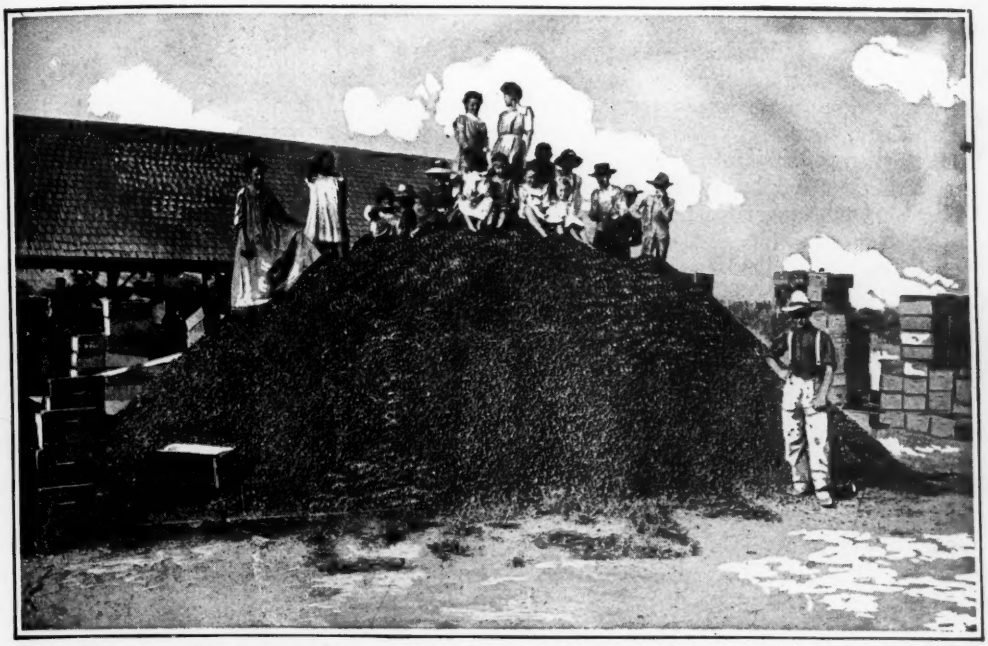
CLIMBING A MOUNTAIN ON A ROPE

These aerial rope-railways are usually employed in mining districts for transporting ore from the mines to the ore-cars. But, near Bozen, Austria, a rope-railway is used for passenger traffic. Passengers are taken a part of the way to the summit of the Kohlerer Mountain on these swinging cars

HOW IT WAS DONE A THOUSAND YEARS AGO



This water lift, still in use on the River Tigris, near Bagdad, is one of the most ancient mechanical contrivances in existence. Inclined uprights, which are lashed together with rope, are fixed near the water's edge, and project above the bank, or over a brick wall, as is the case in the illustration. Rude buckets of hide are suspended by ropes wound on a wooden windlass operated by crudely-applied hand power



These peach pits are the remains of many breakfast dishes of dried peaches

Here Are Tons of Peach Pits

It would be enough to make a housewife shudder to think of paring all the peaches from which came the pile of pits shown here. As a matter of fact they were not pared by hand, but were dried with the skins on and packed by a packing-house at Corning, Calif., and sent East in car lots. The pits weigh many tons and represent about as great a weight of well-dried fruit for winter use in the East.

More Efficient Coal Mining

Three quarters of a million men were employed in the coal-mining industry in the United States in 1914, according to C. E. Lesher, of the United States Geological Survey. Although the average number of days worked in the bituminous mines was the smallest since 1896, except only 1908, and the average output per man for the year was the lowest in five years, the average daily production by each employee in 1914 was the highest on record in bituminous coal mining. This record is to be attributed not so much to the better character of the labor as to improved mining methods and the increased application of scientific management.

In the bituminous mines the yearly average decreased from eight hundred and thirty-seven tons in 1913 to seven hundred and twenty-four tons in 1914. The daily average increased from three and sixty-one hundredths to three and seventy-one hundredths tons. The average yearly production of anthracite by each employee decreased from five hundred and twenty short tons in 1913 to five hundred and five tons in 1914, owing to the fewer days worked. The daily output per man was two and six hundredths tons, a slight gain as compared with two and two hundredths tons in 1913.

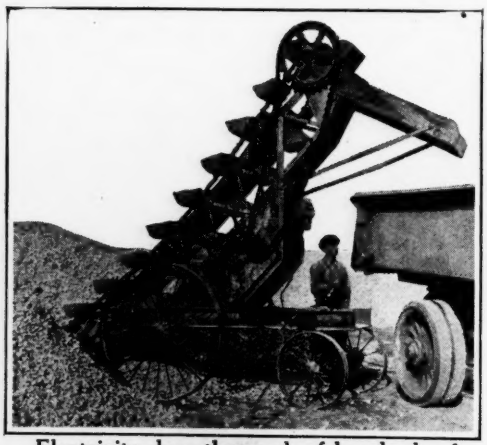
A Chance for Motor Boat Makers

The American Consul at Bermuda reports that that island presents a fairly good market for detachable rowboat motors. It is estimated that there are now about thirty detachable motors in use in the colony, all of American make. These were purchased during the last five years, and it is estimated that under normal conditions it might be expected that from five to ten of these motors could be sold every year. This is one of the markets for American products which will open when the war is over.

Speeding Up the Loading of Motor Trucks

With the increasing speeding-up of deliveries due to the motor truck, there has been a demand for a mechanical loader which would fill the truck in less time than is possible with hand shovels.

An electric motor loader which will dig and load sand, broken stone, and gravel at the rate of one cubic yard a minute has recently been invented. The apparatus is supported upon a wheeled truck, and is easily moved by two laborers. Twenty steel buckets, each having a capacity of one-half a cubic foot of material, are moved on a belt by an electric motor developing ten horse power. The same idea lies at the bottom of another scheme for increasing the efficiency of the motor-truck—this time the tradesman's delivery truck.

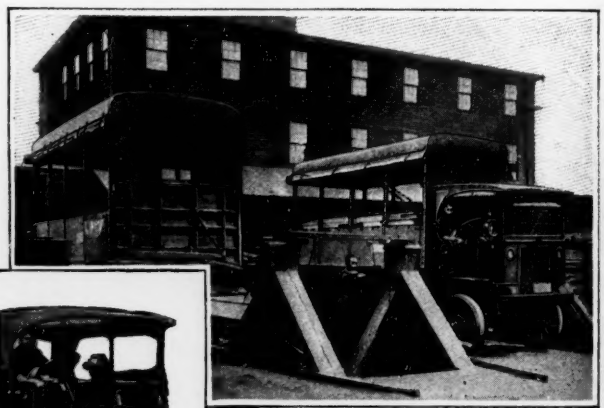


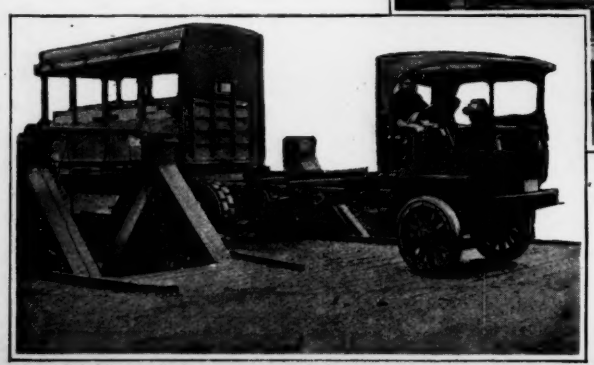
Electricity does the work of hundreds of shovels

A large Boston lumber wholesaler has found that by the use of interchangeable bodies, he could greatly speed up the deliveries of his lumber by motor truck. Two bodies were made for each truck, and while the machine was making deliveries with one of the bodies, the duplicate body was being loaded.

Upon the return of the truck to the yard, the truck was run to a platform, the body was hoisted from the chassis and set on a standard slightly higher than the chassis of the truck. Then the machine backed under the loaded body, which was quickly dropped and secured to the truck.

This method saved much time, as the truck did not have to remain idle while the lumber was being loaded.

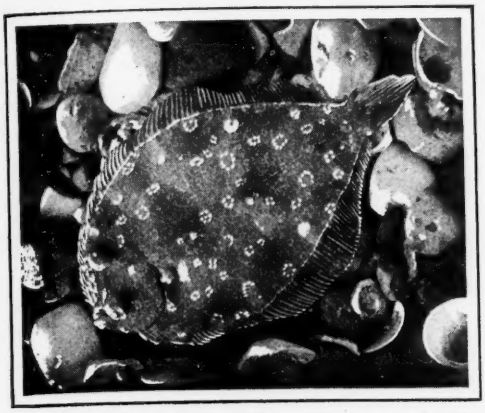




Removable truck bodies are not uncommon now that the power is within the truck and not in horses which can be unhitched Duplicate bodies are made for each chassis. While the truck is making deliveries with one, the other is being loaded, in order to take the place of the empty body

A New Government Grain Sampler

Specialists of the United States Department of Agriculture have produced a new and simple device for sampling grain, seeds and other material. Its purpose is to secure a reliable sample from a larger portion of the material to be examined than would be possible under the old conditions. The principle is the distribution by gravity, of the material to be sampled over a cone which is provided with separate ducts in a way to insure the thorough mixture of the grain. This does away with the destructive method of digging out samples at different points in a pile.

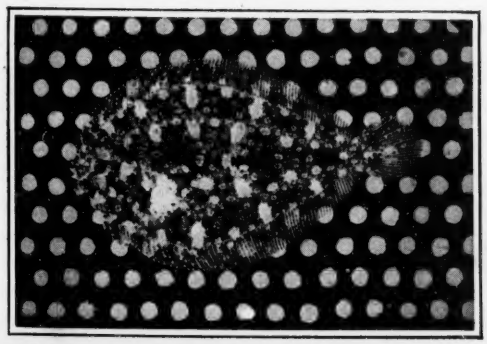


This flounder changes his spots to suit his surroundings

The Masquerades of Fish

Protective coloration among the fishes has occupied the attention of scientists for centuries. Dr. Sumner, of the United States Bureau of Fisheries, recently made experiments with flounders at the famous aquarium at Naples, Italy. He found that these fish are able to make themselves inconspicuous against almost any background, and, unlike the leopard, can change their spots whenever they choose.

Not only were these particular flounders able to adapt themselves to the color of the background, but to the pattern and the texture as well. They assumed a very dark shade upon a black bottom and a very pale one on a white bottom. They took on one pattern for sandy bottom, and another one for fine gravel, and still a third when the bottom was covered with small stones. Variously painted glass strips were prepared and laid down for the fish to practice upon. Some were done in draught-board pattern and others in white "polka-dots" on a black ground.



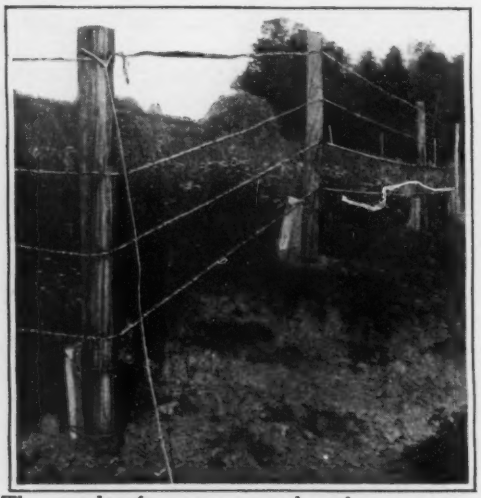
A fish that did his best to look like polka dots

The fish did remarkably well considering that some of the patterns were previously unknown in their little circle of life. Their splotches of black, white, gray and brown approximated the pattern so well that very careful study was often necessary to trace the exact outline of the fish. It was also proved that the flounder has individuality that, in some cases, at least, is capable of cultivation. Some of the fishes have much greater power of adaptation than others. Certain of them acquire with practice the power of changing more rapidly than at first. The time necessary for a complete change of pattern or shade ranges from a few seconds to days.

This tree held a mountain sheep till he died and then grew around its horns

A Forest Tragedy

Two hunters, wandering through the dense forest along the boundary line between Northwestern Montana and Idaho, were surprised to see protruding from the trunk of a lofty white pine tree at an elevation of twelve feet from the ground, a large pair of Rocky Mountain sheep antlers firmly imbedded in the living tree. They carefully cut down the pine and removed the section containing the antlers. They found that the skull was imbedded in the trunk at a point where the diameter is twenty inches. They reached the conclusion that the right antler had been caught on the base of the tree when the pine was about nine inches in diameter. Thus the animal was made a prisoner, and, being unable to escape, perished. The length of the larger antler is twenty-six inches. It is in perfect condition, having apparently been protected by the foliage of the tree. By counting the rings, the tree was estimated to be one hundred years old.



The wooden fence may rot, but the concrete base lasts and is used for a new post

Concrete Fence Post Bases

A new detachable post-base, invented by Alvin Z. Pierce, Woodhull, New York, puts life into aged fence posts. The crumbling of old posts at the base and toppling over is overcome by the detachable bases, which are of concrete and consequently not subject to decay. The bases are reinforced by vertical rods imbedded in the concrete, and also have wires in the concrete and extending across the longitudinal channels of the post bases to provide means for fastening the posts to the concrete.

In a modified form of the invention metal angle plates which serve as post anchors replace the concrete base.

No Signboard Like This

The effect of a huge signboard without the disfigurement of his property by an ordinary painted board was secured by a Los Angeles house owner by using his terraced lawn as the background for the words "FOR SALE," the big letters being formed separately and secured to the sod by pegs. The result is more striking than conventional, requires only a small part of the material used on a signboard of corresponding dimensions, and is by no means as unsightly as a painted announcement.

The sign actually makes the house more attractive

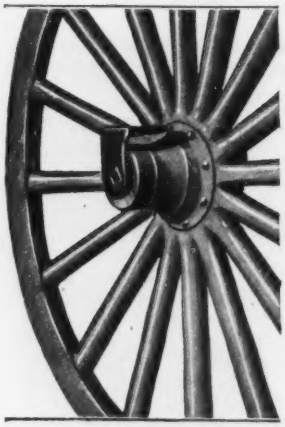
"Magnet Bill"

He doesn't look like a very important part of a big automobile organization, this stooped, grizzled man, but the president of a great motor-car company says that "Magnet Bill" saves his salary a dozen times over every day he works. Rain or shine, summer or winter, "Magnet Bill" may be seen walking slowly about the automobile plant, his eyes on the ground. "Magnet Bill" gets his nickname from the fact that his tools consist solely of one tin bucket and a big steel magnet strapped to the end of a shovel handle. It is his duty to save automobile tires by removing from the roadway every nail and bit of metal that might cause a puncture. Thousands of cars are run over the roadway to the testing place, and it is figured that without the precaution taken by "Magnet Bill" the cost for cut and punctured tires would be twenty thousand dollars every year.

He prevents a hundred punctures a day

Clodomiro Figueroa, the Chilean aviator who made several attempts last year to fly over the Andes, has announced that he will resume his attempts in the near future. The airman follows the route of the Trans-Andean railway from the Chilean side.

Hub Step for Wagons



Here is a hub step that is practicable

The handiest place for a wagon step is on the hub. But until such a step was patented by Joseph A. Butcher, of Dallas, Texas, the idea was never thoroughly applied. His step, which extends over the hub, is cast on a sleeve which slips over and is fastened to the nut of the wagon axle. This sleeve is cut to fit snugly over the nut and is kept from turning by the edges of the nut over which it fits. An overhanging portion of the sleeve which passes over the end of the nut locks it in place and prevents the nut from working loose—a result of considerable importance, for it eliminates the use of set screws and inconvenient fastening devices.

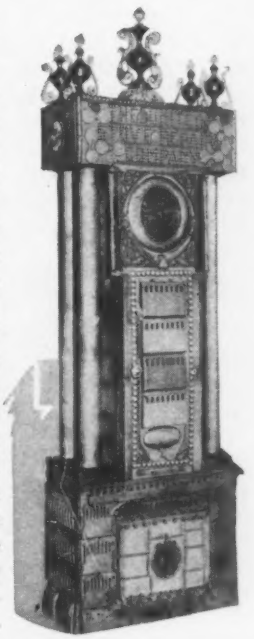
The idea, simple though it may appear from a glance at the illustration, has been the subject of more thought than might be at first supposed. Engineers of several of the large vehicle companies worked for several years with the idea of providing a hub step for wagons and had abandoned it as impractical, resorting instead to the rather dangerous substitute of corrugating the hub of the front wheels to afford a foothold for the driver entering and leaving a vehicle. Stepping on the ordinary hub is a dangerous procedure, though it is frequently done.

Every State Makes Clay Products

It is an interesting fact, not widely known, that clay products are made in every state of the Union, although in the territories, Alaska and Hawaii, have reported none. Last year's production was valued at one hundred and sixty-four million, nine hundred and eighty-six thousand, nine hundred and eighty-three dollars.

Clock Made of Stove Repairs

A Philadelphia stove maker has constructed a "grandfather's clock" of the waste materials of his factory. This clock stands eight feet high and is thirty-four inches wide. The dial, of mica, is eight inches across. The words "Stove Repairs" compose twelve letters, used in place of figures on the dial, which is illuminated from behind by an electric light. The hands are of eighteen gauge wire. The base of the clock is composed of grates for ranges, and the center of the front is inlaid with fire-bricks. In the center of the brick panel is a three-bar grate, representing the trade-mark of the maker. The main body of the clock above the base is composed of grates for ranges on the front and fire-plates on each side. Nickel knobs outline the door, and a nickel panel represents the window for the pendulum. The space surrounding the face is constructed of brackets of top end shelves of cook stoves, and an an eight-inch pipe collar forms the frame for the dial. The columns on both sides of the body are of four-inch black stove pipe that rests on water backs, and four-inch pipe collars add a finish to the ends of the columns. The words appearing at the top of the clock are made of nickel damper knobs.



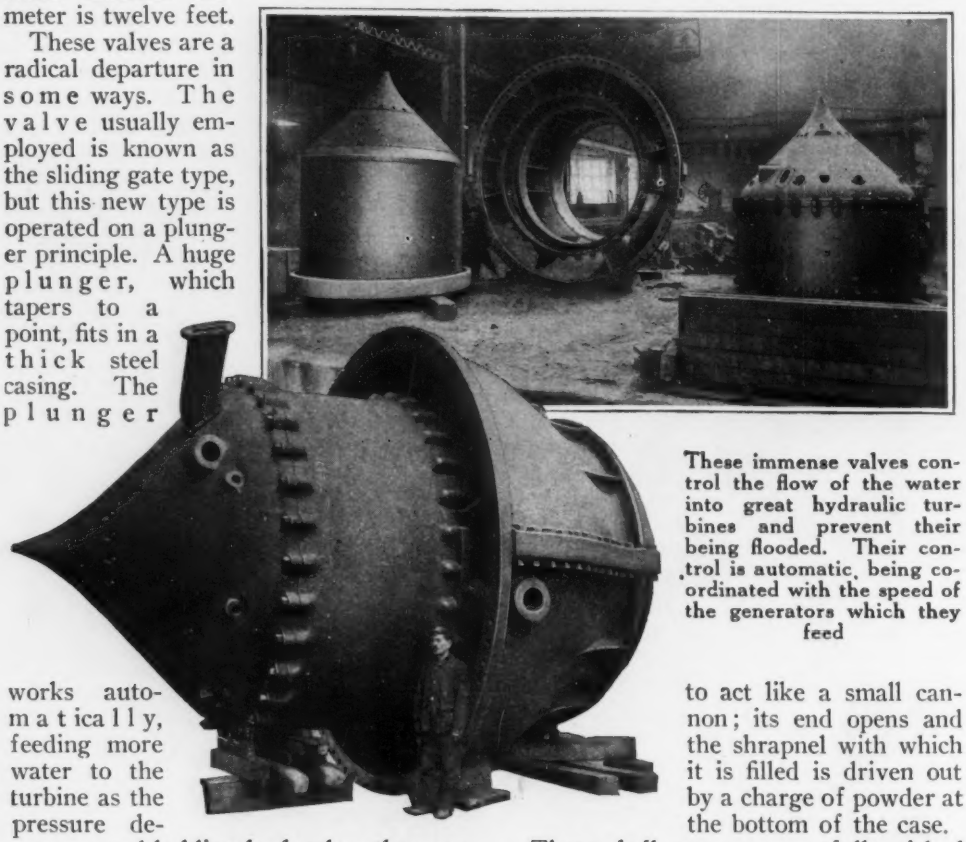
It looks like a stove but it is a clock

A waterback hole, covers for ranges and stove rods help to finish off the space around the letters. Hinge caps form a bead around the edges. Slip plates for ranges, in which flue-stops are inserted, finish the sides of the top. Five urns are mounted on the summit. The total weight of the structure is about three hundred and fifty pounds.

Giant Valves for Water Power Plant

Two hydraulic valves, believed to be the largest ever constructed, have been erected at Salt Lake City for a hydro-electric plant, which supplies lighting and power current. Each of the valves weighs more than ninety tons. An idea of their immense size can be gained by a comparison with the pigmy-like figure of a man standing beside one of them. Their internal diameter is twelve feet.

These valves are a radical departure in some ways. The valve usually employed is known as the sliding gate type, but this new type is operated on a plunger principle. A huge plunger, which tapers to a point, fits in a thick steel casing. The plunger works automatically, feeding more water to the turbine as the pressure decreases, and holding back when the pressure increases. Encased in its cylinder, the valve has an over-all length of over twenty-three feet.



These immense valves control the flow of the water into great hydraulic turbines and prevent their being flooded. Their control is automatic, being coordinated with the speed of the generators which they feed

Each of the turbines to which the giant valves will deliver water has an electrical output of ten thousand horsepower. They are driven by water with a head of one hundred and forty feet.

Horses and mules to the number of 436,760 were shipped to Europe and Canada during the twelve months beginning with August, 1914.

Germans Furnish French with Excellent Bomb Throwers

One of the newest French bomb throwers is as simple as the brass guns that small boys delight to play with. It consists of a German shrapnel shell case mounted on a wooden stand, with a spike in front to anchor it firmly to the ground. The case of the shrapnel remains intact after it has been fired, as its object is to act like a small cannon; its end opens and the shrapnel with which it is filled is driven out by a charge of powder at the bottom of the case.

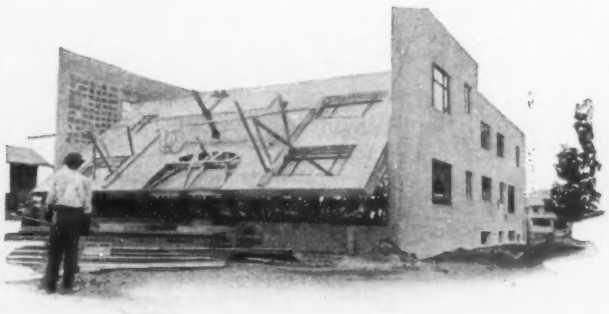
These shell cases are carefully picked up by the French to be used against the enemy. They are cut down, and a touch-hole is bored in them. The cost of the finished bomb thrower is but little over a dollar.

To use them, a charge of powder is poured into the shell case, and a bomb, well loaded with explosives, is placed upon it. The charge is fired by the touch-hole, and the bomb is thrown into the air. It turns clumsily over and over like a large sausage, but it finds its target with remarkable accuracy.

Walls Are Built Like a Floor

Building a house wall like a floor and then tilting it to an upright position is an original system of construction which has been so perfected that at present it is used for large and costly concrete structures, saving time and material.

Walls up to one hundred and twenty feet long have been raised by this method, and many of the structures built by the Federal Government such as barracks, military hospitals, cavalry stables and other military buildings of standard type, which have long but not high walls, were erected by this system.



The walls are built of concrete on the ground and then raised to their places in the completed house

In building an edifice by this method, the foundations are laid and within them a series of steel-trussed frames is set up in perfect alignment. The frames are placed a few feet above ground, in an almost horizontal position, and they are set a few feet apart and at right angles to the foundation. These frames carry the wall, so that after the concrete has had time to cure the supports are brought into an upright position, setting the wall squarely upon its foundation. The raising is done by telescope screws of unusual length, one under each steel frame. The jackscrews are operated simultaneously by a worm gear which turns all of them at an equal rate, the motive power being a small engine. The tilting is very gradual and the wall comes into position without any jar or shock.

There are many advantages in this system. In the first place the forms are laid flat upon the steel frames, not built in an upright position, and the work of placing the forms is done in less time. About half the lumber used on other forms is all that is needed by this method, as the upper surface requires no forms. This upper surface (when the wall is horizontal) is the outer surface of the wall when it is set upright, consequently all the disfiguring board marks are on the inner surface, which receives plaster or other interior finish. The smooth surfacing of a concrete wall is difficult and costly, but by this method it is readily accomplished, for the finishing coat and all decorative features can be added while the concrete is wet, in which condition the adhesion is perfect. This is one of the most advantageous features of the system.

A Bridge Made of Scrap Iron

Carrying an important highway over the Calumet river not far from Chicago is this unusual bridge made from steel scrap salvaged from other structures. The character of the material is shown to every passerby by the empty rivet holes, which are visible in the photograph in the top of the conical plate serving as abutment walls to hold the highway fill and in the angles bracing the truss. The curved braces between the piers at the center of the stream are old railroad rails.

This simple bridge was made from scrapped structural steel

Making Push Carts of Truck Bodies to Save Time and Money

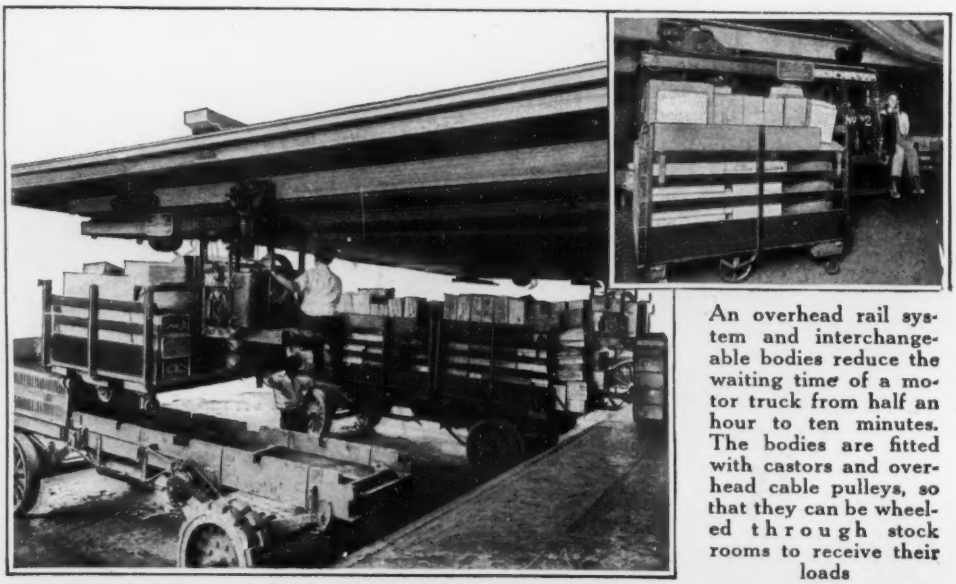
A highly efficient loading system for trucks has been developed by a Los Angeles wholesale grocer, who finds it a great saver of time and truck drivers' salaries. Hours wasted in loading are both actual cash outlay and loss of capital return on the investment in vehicles.

The waiting time at the warehouse is reduced from half an hour or even a full hour, to ten or fifteen minutes, by an equipment of extra bodies for the motor trucks and an overhead rail system, which carries these bodies through the warehouse at a rapid rate. Even the design of the bodies is original, each consisting of two interchangeable units, which are furnished with steel hooks so that they can be lifted bodily from the chassis. Each unit is in reality a hand truck, as it is furnished with castors so that it can be pushed for short distances.

When a truck has finished a morning delivery to retailers, it returns empty to the warehouse and the driver makes his report to the office. Meanwhile the two parts of the empty truck body are lifted from their place by means of the overhead system and instantly replaced by two loaded units, with the contents arranged for systematic delivery and properly checked up. This means no loss of time on the driver's part. He is ready for the second delivery at once.

The empty bodies are handled, inside of the warehouse, like the usual hand trucks, and they are loaded for the truck's delivery with one action of the workmen. For instance, the body unit is sent to one part of the building for a hundred pounds of sugar, to another for a drum of coffee or case of corn. Probably some of the goods ordered are on an upper floor, and in that case the elaborate conveyor system carries the body unit into a freight elevator, which is furnished with an overhead rail, and on the next story the device is switched upon the conveyer system of that story. Very little pushing about by hand is required. Finally the loaded unit is sent to the loading platform to await an empty truck, on whose arrival it is set upon the chassis in five minutes, the second loaded unit is placed beside it and the truck is ready to make deliveries.

It is easy to see that the number of trucks is reduced by a system which keeps them busy all the time, so that the interest on the investment in machines is saved. Another point is that confusion of the loading platform is eliminated, and goods can be checked carefully, avoiding mistakes and loss. Each of the carriers for the overhead system is in charge of one man, who rides beside the motor and controls it.



An overhead rail system and interchangeable bodies reduce the waiting time of a motor truck from half an hour to ten minutes. The bodies are fitted with castors and overhead cable pulleys, so that they can be wheeled through stock rooms to receive their loads

An Electric Piano Player Controlled by The Moving Picture Operator

The electric piano player shown in the illustration makes possible the instantaneous change from one piece of music to another at any moment and is particularly adapted for playing pianos in moving-picture theaters. By means of endless perforated rolls, the operator of the lantern can instantly change the type and tempo of the music from the rear of the house, without any other attention to the piano. Bellows are eliminated by a series of electrical points which actuate hammers that play on the keys of the piano. The musical program embraces thunderous music for battle scenes, fast, snappy music to accompany animated scenes, such as horse or automobile racing; pathetic music for heart-rending scenes, and so on down the gamut of human emotions. And all are under the instant control of the operator in the lantern booth. Thus, the wrong music at the wrong time is avoided; while the appropriate music is supplied at the will of the operator, who is best able to judge the requirements of the scene. The player-piano is a "property" at picture theaters.

This electric piano, with endless perforated rolls, is controlled from the operator's booth

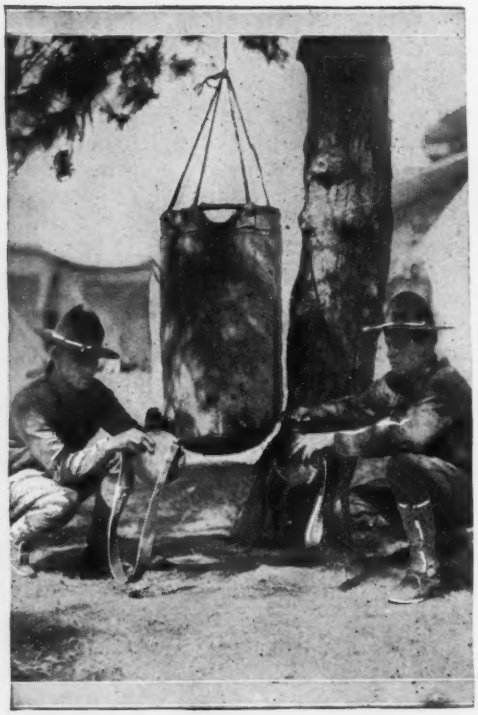
Repairing an Aeroplane Under Fire a Mile in the Air

The thrilling story of an Australian air pilot who was strung by one hand to the framework of a disabled aeroplane five thousand feet over the enemy's lines while executing repairs with the other, was told by an officer observer from Northern France.

"We had crossed the German lines and their guns were booming at us from way down below when Cornstock (the pilot) noticed our left wing was tilting down and not responding to the controls," said the officer. "He swung out of the seat to the right side, but the plane continued to tilt, and it looked as if we were going over sure.

"Cornstock let himself down with nothing but thousands of feet beneath him, holding tight with his right hand and fumbling with the control wires where they were jammed under the body of the machine.

"The strain on his right arm must have been terrific. Seconds seemed hours as he swayed there, his legs dangling in space while the machine swung over 'air bumps' and levered to the side. As a feat, it was superb."



When the new army filter bag has stood for ten minutes, the water may be drawn off through spigots

Our Army's New Water Works

Through an ingenious invention of Major W. J. Lyster, U. S. A., typhoid fever and other sicknesses caused by drinking impure water are practically banished from the army now by the use of a very simple sterilizer.

This wonderful invention, which now gives regiments of soldiers an abundance of pure water by a quick conversion of the impure water, consists of a hemp bag and a very small quantity of hypochlorite of calcium.

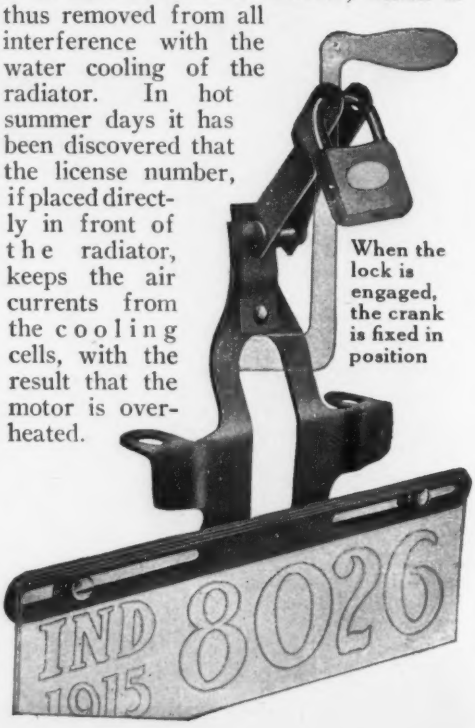
These hemp bags are large enough to hold 40 gallons of water into which is mixed 1 gram, or 15½ grains, of calcium hypochlorite. The bag is suspended from a tree, or a tripod, if no trees are handy, and allowed to stand for ten minutes. At the end of that time the water in the bag may be drawn off through spigots at the end of the bag and used for drinking with perfect safety. The hypochlorite of calcium kills all dangerous germs, both animal and vegetable, in the impure water and no boiling is necessary to render it sterile.

Each bag is twenty inches in diameter and twenty-eight inches long.

Not only is the new invention a great advantage for the army, but the method of purifying water quickly and effectively with a small bit of calcium hypochlorite lends itself admirably to private use.

New Crank Lock for Light Automobiles

Holding the starting crank in a rigid upright position, preventing unauthorized use of the car, and in addition providing a logical place for the front license number, are the advantages of a new crank lock, especially suited for Ford cars. As will be seen from the illustration, the device is simplicity itself. It consists of a bracket, slipped over the cranking handle with a forked upper end, through the holes of which a Yale lock is put. A flat steel spring holds lock and fork against the cranking handle, preventing its rattling and forcing the fork back against the radiator when the lock is removed. The lower end of the device is arranged so as to take the license number, which is thus removed from all interference with the water cooling of the radiator. In hot summer days it has been discovered that the license number, if placed directly in front of the radiator, keeps the air currents from the cooling cells, with the result that the motor is overheated.



When the lock is engaged, the crank is fixed in position

Shipping Live Fish

Carrying live fish from the Great Lakes to the cities of the Atlantic seaboard and the Middle West has brought the delicacy of carp and "whitefish" to epicures quite outside the former limits of the lake fish "belt."

This has been made possible by means of a regular system of delivery in tanks of fresh water by express. The arrangement of the express tank-car is interesting. A narrow aisle runs down the center, and on both sides range large metal tanks with heavy metal covers. A labyrinth of pipes and ventilators hangs above. Within these tanks, ten in number, swim some three thousand live carp, perfectly at home, for the tanks are filled

Three thousand live carp ride in railway car tanks, filled with Lake Erie water

with Lake Erie water. Ten thousand pounds of live fish ride to market in a single car.

It would hardly do to throw the fish into the water-filled tanks in Sandusky, Ohio (most of them are shipped from there), and expect them to be fresh and well after a journey to the Atlantic seaboard. The water would soon grow stale and the fish die. A system of aerating the contents of the tanks was, therefore, necessary. When the train is in motion it was easy enough. As passenger coaches are lighted by electricity generated on their own axles, so the live-fish car gets its power from the axles to force air into its water tanks. But when the engine stops and the tank-car stands still for a space of time even so short as three minutes., a little Pintsch gas engine underneath the tank-car is busy driving the air-pumps. The water is kept in a constant state of fomentation during all stops. Were the aeration process to cease for a few minutes the death rate of the finny cargo would take a leap. The transportation of live fish is a delicate matter.

Careful handling begins long before this, however. It began back in Sandusky harbor the very moment the carp are caught. There is a science in handling live fish for overland transportation trade. Designers have constructed special "carp-cars," a sort of wooden crib that floats in the water, full of caught fish. Whole trains of them string by the shores of shallow Sandusky Bay, a throbbing "locomotive" (a motor dory) hauling them to the packing piers, where the tank-cars are awaiting their loads.

A "Carp Car" with special fences to prevent the loss of flopping fish

Each "car" has a capacity of nearly a thousand fish, and is twenty-eight feet long, seven feet wide and thirty-two inches deep, with three-foot rail fences lined with canvas on top to prevent the lively, flopping carp from escaping back into the lake. With the special "carp-cars" or the like and the tank express cars, the loss of fish amounts to only one per cent.

A Prop for Capsizing Cars

Some of the French military motor trucks have been equipped with rods which swing out to arrest the tilting when the truck threatens to capsize on a badly crowned road. This tilting tendency is immediately arrested by the feet on the ends of the rods, as these prop the car up as it starts to fall.

War Eliminates the Rotary Motor

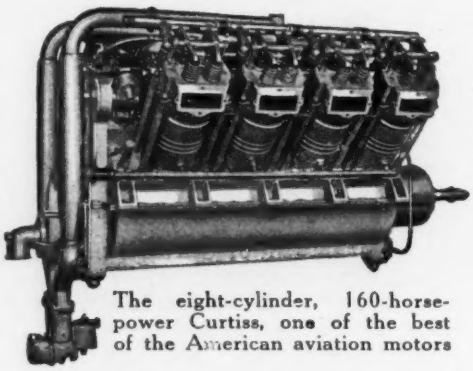
One of the mechanical features of the European War has been the unexpected failure of the rotary type aviation motor and the triumph of the fixed cylinder engine. The result of a year of the most strenuous work that aeronautical motors have ever undergone is that the rotary motor is already in disfavor in Europe, and the fixed engine is supreme.

Most readers will remember the sweep which the famous Gnome rotary motor made of American flying exhibitions and contests a few years ago.

The rotary triumphed in the days when flights were of comparatively short duration and the great cost of operation counted little, and when intricate mechanism was no drawback because there was always a large force of skilled mechanicians to make repairs and adjustments.

Under war conditions, faults come to light. Flying corps were composed of men who had only average mechanical knowledge. If there were repairs, they had to be made by the flyers themselves, often under fire. The failure of the motor meant capture, often death. Flights were of a longer duration, and heavier loads had to be carried, and all sorts of weather had to be encountered.

Under peace conditions it was difficult to get all the facts in regard to actual

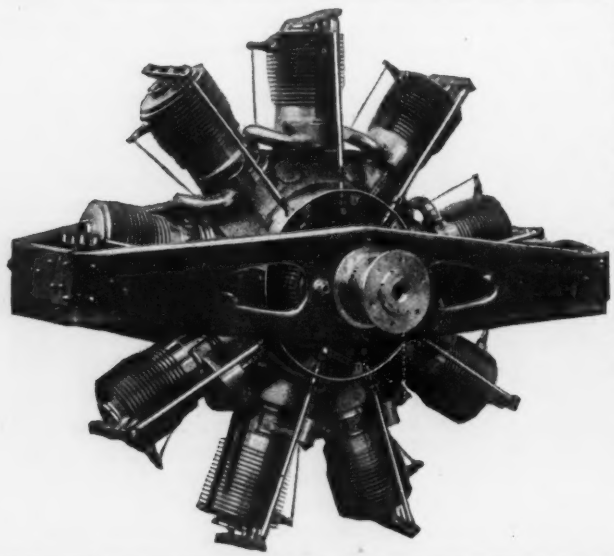


The eight-cylinder, 160-horsepower Curtiss, one of the best of the American aviation motors

motor conditions. Everyone was ready to believe that the aviation motor was extremely delicate, but they were surprised to learn that the average life of two prominent makes of rotary motors was four and twelve hours, respectively. Several hundreds of a certain rotary motor averaged but four hours' actual service.

One of the chief defects of the rotary motor is its extraordinary oil consumption. One of the most important European motors of this type has an oil consumption which is thirty per cent. of its gasoline consumption. A successful water-cooled motor of the stationary type has an oil consumption of only fifty-seven hundredths of its gasoline consumption.

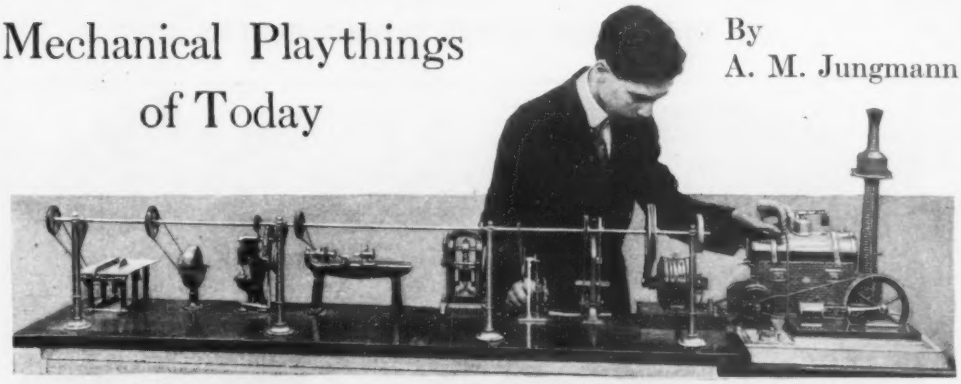
Although the rotary motor is famous for its lightness, figures show that under flying conditions it is really heavier than the stationary motor. A rotary engine of two hundred horsepower will weigh about six hundred and sixty-three pounds, while a fixed-cylinder machine weighs about one thousand and ninety-nine pounds. This seems to give the rotary a great advantage, but when the tanks are filled for a flight the advantage swings the other way. For a flight of ten hours the rotary engine weighs two thousand eight hundred and forty-one pounds, while its rival, with the fixed cylinders, weighs but two thousand two hundred and three pounds. In warfare, where it is often necessary to carry great weights, this saving in fuel is very important.



The Gyro 90-horsepower motor, a popular American engine used on flying machines

Mechanical Playthings of Today

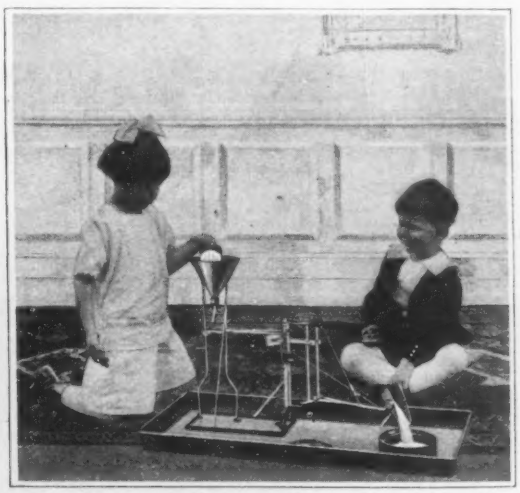
By A. M. Jungmann



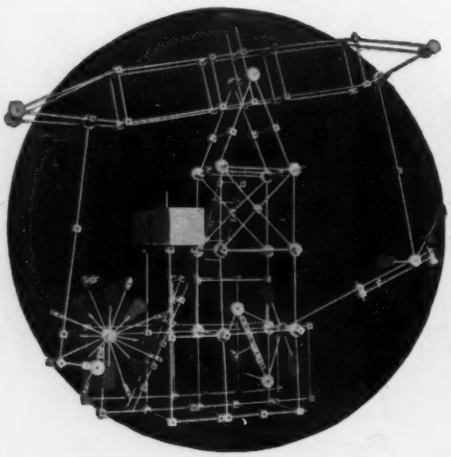
A steam engine furnishes the driving power for a small electric motor. This, in turn, rotates a shaft which drives many different toy lathes, grinders, pumps and jig saws, making, in its entirety, a miniature machine shop

GONE is the little tin soldier who bravely entered the ranks at Christmas only to disappear, mortally wounded, by New Year's Day. And gone with him is the doll with the sweet china face and wig that would not stay on; gone, also, are the impossible building blocks that built delightfully impossible structures which were never seen on land or sea. The watchword of today in toyland is education. And to attain that end we must have lasting toys. For what child can learn the principles of anything from a toy that is broken in a week? And so, instead of the gallant but weak tin soldier with his useless gun, we have unbreakable soldiers and guns that really shoot in quite as businesslike but not as dangerous a manner as do those which are devastating Europe this minute. The sweetly pretty doll with the lovely but silly and breakable china face has yielded supremacy to the unbreakable character doll. Prettiness will not answer any more unless it means something. The building blocks that built castles, whose only architect was the imagination of childhood, have given way to construction toys which duplicate accurately all the structural work fathers and uncles risk life and limb to accomplish.

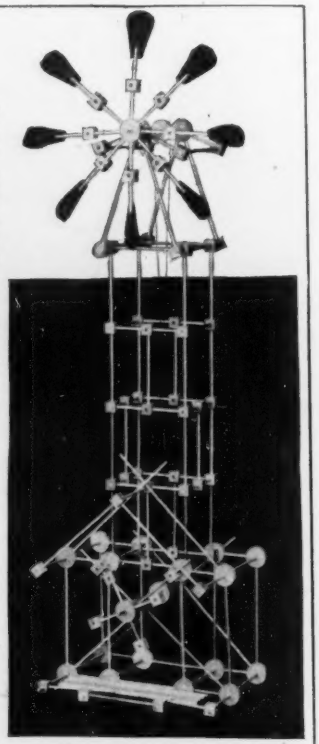
The original purpose of toys, which is to amuse, has not proven sufficient to the American child. Toys which merely amused were cast aside in so short a

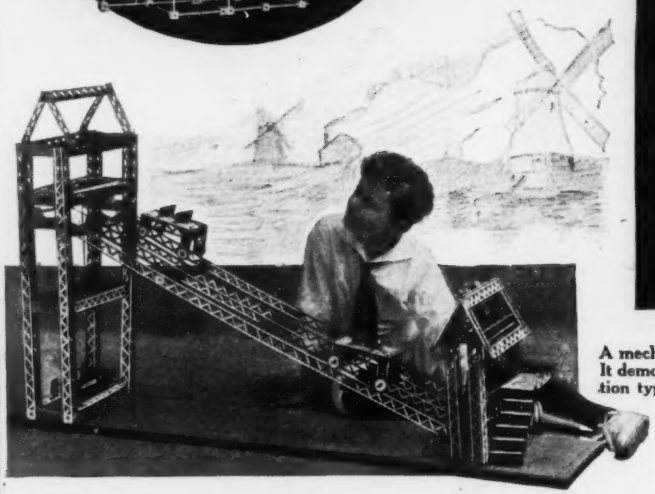


The skyscraper express elevator is operated by dropping marbles. One marble causes the car to descend and the counterweight to ascend. To the right is a sand crane. As soon as the crane receives its load, it dumps the sand opposite the loading point; then the crane returns



A large walking beam engine. The boy builder learns how a walking beam operates when he makes this toy. The motive power is sand which runs out of a hopper and falls on a paddle wheel. The paddle wheel imparts movement to the connecting rod of the walking beam, which transmits power to the welding hammer connected with the other end of the structure

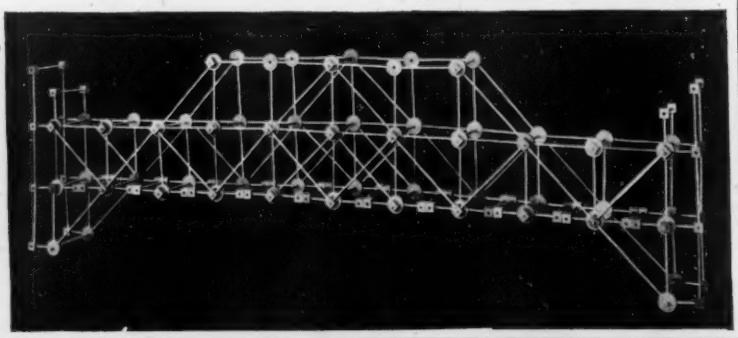




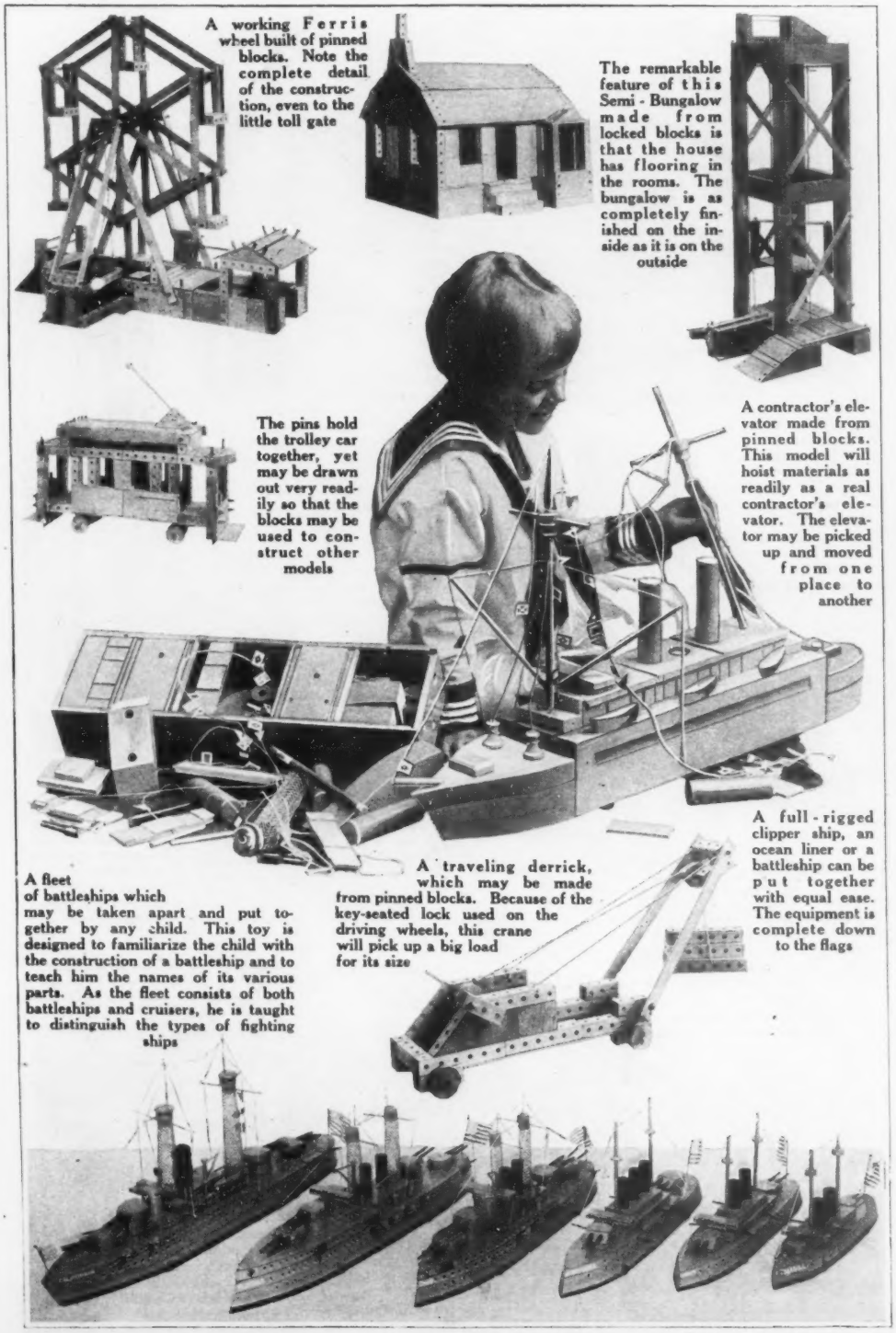
A mechanical mill made easy to construct. It demonstrates the principle of the regulation type of farm windmill. The bladed wheel at the top is connected with the grinding wheel at the bottom by means of a string belt. An electric fan whirls the mill around very realistically

An inclined railway built up of small girders. This model is fashioned after the inclined street railroads in operation at Pittsburg, near the Pittsburg and Erie Railroad. The cars descend by their own weight. They can be lifted by means of a motor or by hand. The pulleys at the bottom beneath the power house are mounted on shafts over which the cables are run. The two ends of the cable are attached to the two cars

A bridge constructed from the same parts as the walking beam engine and windmill at the top of the page. This bridge is five feet ten and a half inches long and fifteen inches high



TO CONSTRUCTION TOYS THAT EDUCATE



A working Ferris wheel built of pinned blocks. Note the complete detail of the construction, even to the little toll gate

The remarkable feature of this Semi-Bungalow made from locked blocks is that the house has flooring in the rooms. The bungalow is as completely finished on the inside as it is on the outside

The pins hold the trolley car together, yet may be drawn out very readily so that the blocks may be used to construct other models

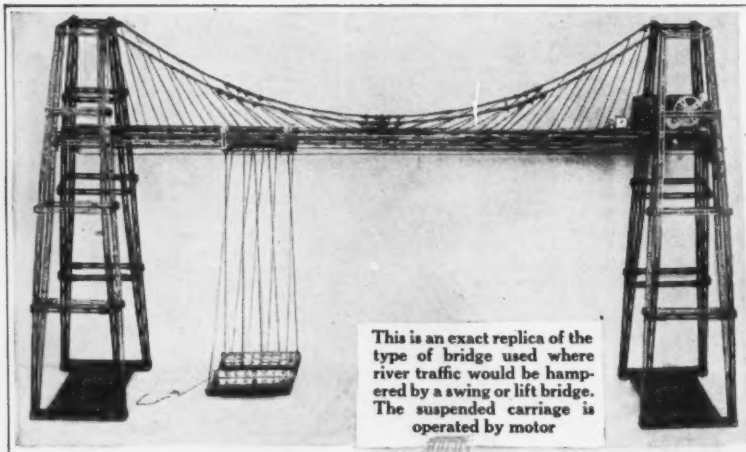
A contractor's elevator made from pinned blocks. This model will hoist materials as readily as a real contractor's elevator. The elevator may be picked up and moved from one place to another

A fleet of battleships which may be taken apart and put together by any child. This toy is designed to familiarize the child with the construction of a battleship and to teach him the names of its various parts. As the fleet consists of both battleships and cruisers, he is taught to distinguish the types of fighting ships

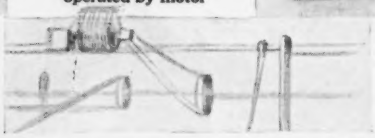
A traveling derrick, which may be made from pinned blocks. Because of the key-seated lock used on the driving wheels, this crane will pick up a big load for its size

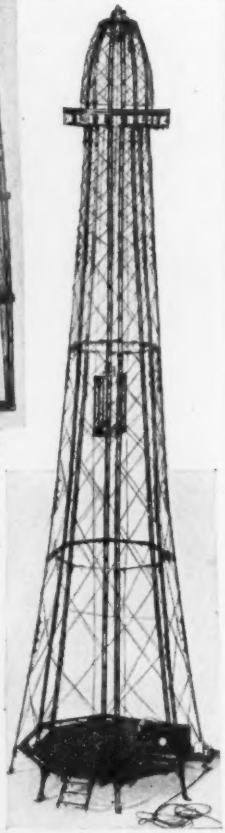
A full-rigged clipper ship, an ocean liner or a battleship can be put together with equal ease. The equipment is complete down to the flags

ENGINEERING STRUCTURES REPRODUCED IN MINIATURE

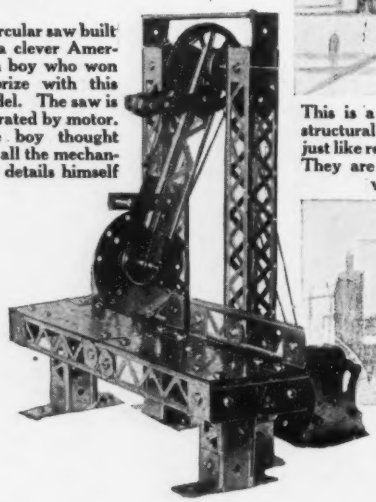


This is an exact replica of the type of bridge used where river traffic would be hampered by a swing or lift bridge. The suspended carriage is operated by motor

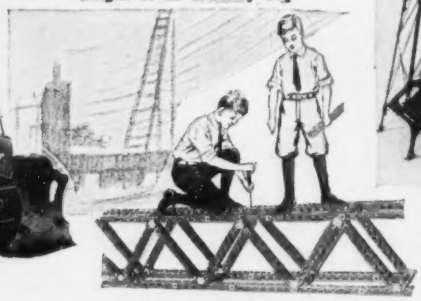




A circular saw built by a clever American boy who won a prize with this model. The saw is operated by motor. The boy thought out all the mechanical details himself

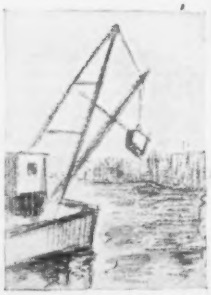


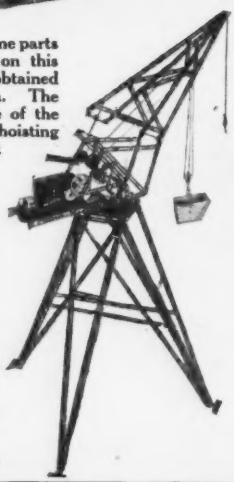
This is a construction toy which resembles structural steel work. The girders are made just like real girders used in construction work. They are so strong that they will bear the weight of an ordinary boy

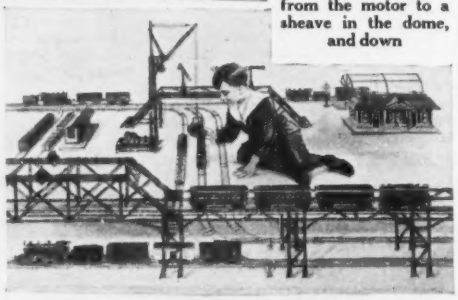


Sight-seeing tower which rises to a height of five and a half feet. The cage is operated by a cord which is led from the motor to a sheave in the dome, and down

A dock crane built of the same parts as the sight-seeing tower on this page. Variable racking is obtained by a jib-adjusting motion. The spindle gear alters the rise of the jib. Equipped with two hoisting drums this crane will lift two loads at once



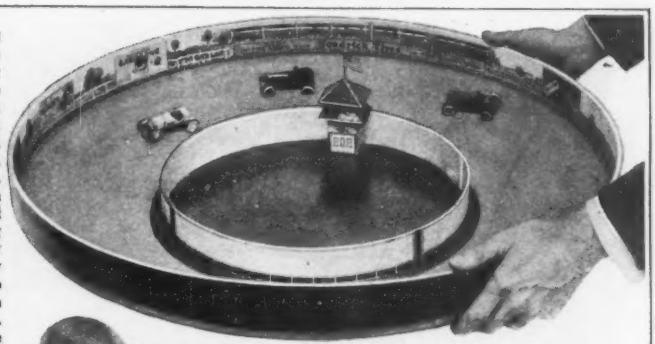




A construction toy designed to teach the principles of mechanical engineering to a boy. The material employed consists of perforated steel strips, plates, angles, pulleys, gears, brackets, axles, cranks, as well as a screw-driver, screws and nuts. The boy can make any number of working models with this outfit

GAMES AND TOYS WHICH AMUSE BECAUSE THEY ARE ALIVE

Brooklyn boys conceived the idea of nailing roller skate wheels on a long board on top of which they fastened a wooden box. By standing on the board and propelling themselves by one foot they managed to derive much amusement. This toy is the Brooklyn boys' idea cleverly carried out.



The "Speedway." The track rests on a pivot and the motive power for cars is obtained by a slight rocking motion of the board. The cars will race around the track as fast as eighty laps a minute. Each car can be controlled by the person operating the toy

A doll-wheel-toy. Amusing and durable. When pushed or pulled the figure has a realistic action as though he were operating a hand car. The movements of the body and car cause the bell to ring

These vehicles are operated by clock work to run seventy-five feet. The toys may be made to travel in a straight line or by turning the front wheels they may be made to describe a circle. The hook and ladder is particularly clever. When wound up it will travel toward the building supposed to be burning and on touching it the ladders automatically raise themselves against the object

A miniature operative talking machine. It is carefully constructed, the appearance is pleasing, the records clear and it is not easy to get it out of order

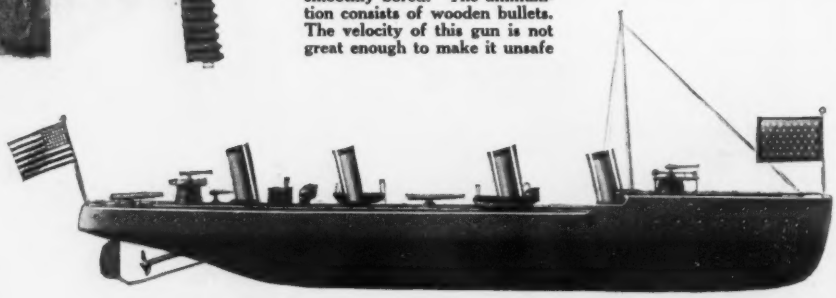
When a string is tied to the toy and it is drawn along, the revolution of the front wheel causes the doll to pedal. Because it is mounted on a pivot, the doll sways from side to side while it pedals and has the life-like motion of a small boy on a velocipede

HOW THE WAR IS REFLECTED IN TOYS

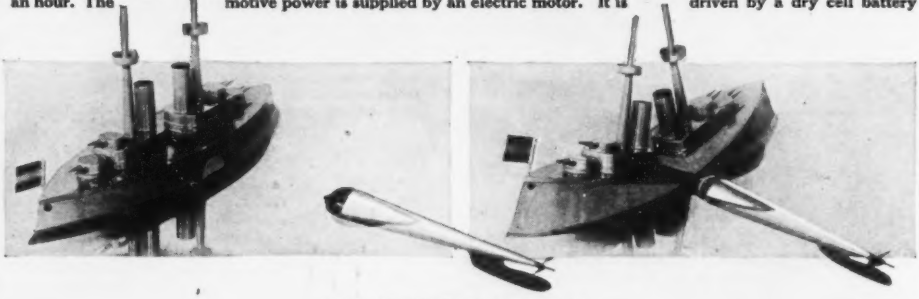
A toy field piece which shoots soft rubber balls as rapidly as a lever can be depressed. The gun can be taken apart and reassembled. This is a perfectly safe military toy. The soldiers to the right are knocked over by the gun

A fifty-shot pistol repeater, which handles roll caps. It is like a real repeater in appearance

A very realistic toy machine-gun is modeled after a modern rapid-fire military gun that shoots one hundred and eighty thousand times without stopping. The barrel is of wood, smoothly bored. The ammunition consists of wooden bullets. The velocity of this gun is not great enough to make it unsafe

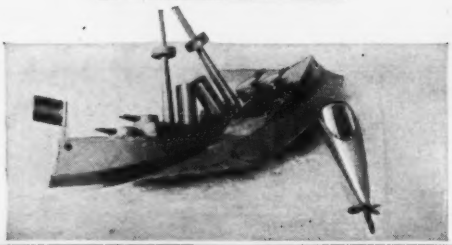


This warship is modeled after the Torpedo Boat Destroyer "Decatur," U. S. N. It is 36 inches in length. It has low-built upper works, four oblong smokestacks, two turrets, five rapid-fire guns and two deck torpedo tubes. It carries a lifeboat hanging on davits which may be turned to swing full offboard. The torpedo will travel at a speed of four miles an hour. The motive power is supplied by an electric motor. It is driven by a dry cell battery



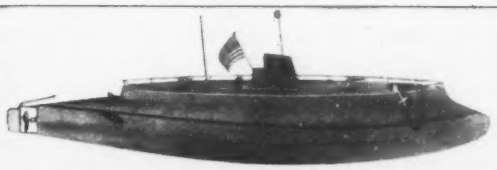
THE SINKING BATTLESHIP

This realistic toy is actually operated in water. The battleship floats until the torpedo strikes the target, which releases a spring; the battleship opens in the center, fills with water and sinks. The torpedo is wound up and then released. If well directed it will hit the target. The battleship, after the encounter, may be taken out of the water and held in a vertical position until all the water in it has run out of the portholes of the lower end; then it can be snapped together and is ready for the next encounter

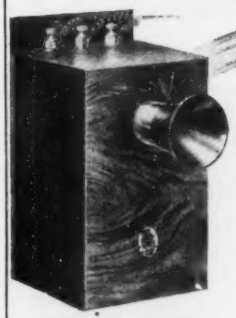


PRACTICAL USES OF ELECTRICITY REFLECTED IN TOYS

For the little girl who wants to play house here is an electric stove that really cooks. There is no danger of fire, yet the child can bake, boil or fry food on it



A submarine designed from a photograph of an American submarine built in the Brooklyn Navy Yard. This boat measures twenty-eight inches in length. It may be submerged so only one quarter of it can be seen above water. It will run four knots an hour and rams anything in its way. The motive power is furnished by an electric motor

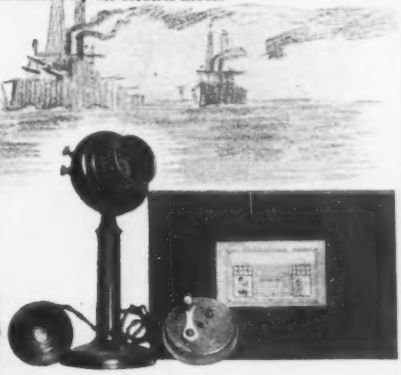


This is a telephone device which will stop or start electric trains. The child simply speaks into the telephone and orders his train to stop. It will work on either alternating or direct current

This electric motor boat is exactly like the motor boats used as pleasure craft

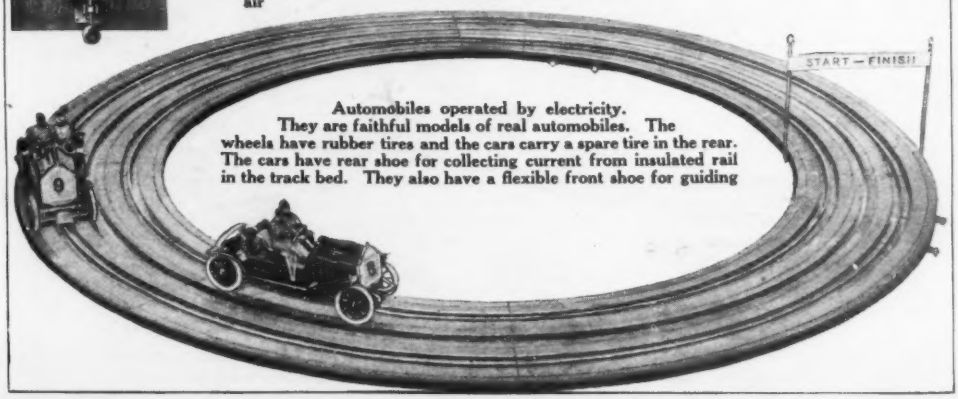
A toy which teaches a boy wireless. When in operation this toy sounds precisely like a wireless station when messages are being flashed through the air

Electric trains and motors teach boys to become familiar with electricity as motive power. The roofs of the cars are removable. The boy may make figures of men and women and put them in the cars. The locomotives are made of steel



Above: An ingenious and simple toy which teaches children something about the elements of the telephone

Below: Toy which will enable a boy to learn telegraphing



Automobiles operated by electricity. They are faithful models of real automobiles. The wheels have rubber tires and the cars carry a spare tire in the rear. The cars have rear shoe for collecting current from insulated rail in the track bed. They also have a flexible front shoe for guiding

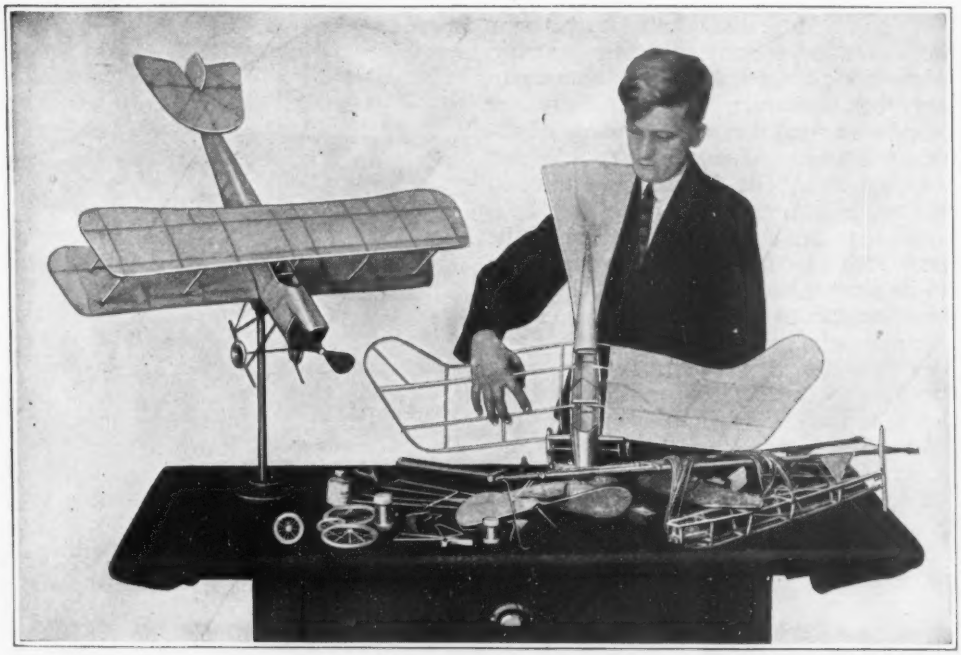
time that it seemed that their mission was not fulfilled. The restless spirit of the age extends to the children. In order to hold the attention of the children toys must have a purpose. As soon as this fact was borne in upon our toymakers they began turning out toys which were designed to make the child think and learn at the same time they were amusing him. The great success of the construction toys indicates that toys with a purpose are a childhood necessity.

As this is a mechanical age it is only natural that the toys we make for our children should be, in a very large measure, mechanical. Children have always loved to see the wheels go 'round, but nowadays they want to know why. To meet this growing demand many of the mechanical toys are so constructed that the child can take them apart, examine the mechanism, and put them together again. This means that the construction must be simple and the material strong. A child who shows an aptitude for mechanics subconsciously absorbs an understanding of mechanical principles while he is playing with his toys.

That children are naturally destructive would seem to be controverted by the enthusiasm with which they have welcomed the construction toys. They appear to take quite as much delight in constructing things out of these new toys as they did in breaking the old-time ones. The child with an inclination for engineering, or for any sort of structural work, may find toys with which he can build anything from a windmill to a railroad bridge, from a crane to an elevator. The great merit of these construction toys is that the child can make working models from them. If the child happens to see a crane which attracts his attention he can go home and build one like it and operate it by electricity, too, if he so desires, for the better construction toys are capable of developing models which may be so operated.

All the great construction work that has made these United States famous for their engineers finds its miniature counterpart in toydom. A toy railroad, for example, is not built after the toymaker's idea of a railroad. The locomotives, the cars, the switches are all faithfully copied from locomotives, cars and switches actually in use on one of the great railroads of the country. If a railroad brings out a new style of car it is only a matter of a very short time before a miniature of that car will be found running over the rails of a toy railroad. All this attention to detail is educational. The child gets to know the

Boys of to-day are no longer content with the impossible building-blocks of other days. They want to build Ferris wheels, aeroplanes, cranes and trucks



With this set of parts, this boy has made an accurate flying model of the German Taube and American Curtiss. On the table in front of him will be seen a partially completed model of the small racer designed by Cecil Peoli, a model which holds the world's record

different types of railroad equipment, he recognizes the cars when he sees them in actual service, he learns the signal systems and becomes familiar with the construction of a railroad and the principles of transportation.

The same thing is true of toy boats. From a sailing vessel to a battleship the toy boats are copied in every detail from boats engaged in the business of life. Like other toys of to-day boats may be taken apart and put together by their small owners. This gives them the opportunity to learn the principles of marine architecture.

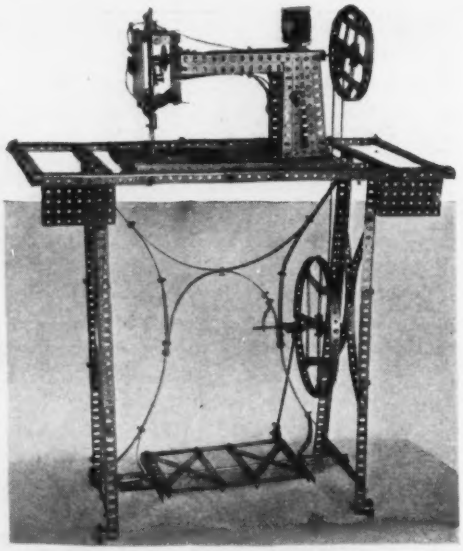
The growing demand for educational toys has led the toymakers of the United States to bend their energies toward the construction of this particular class of toy. Before the present European war broke out there were toy factories in twenty-three of the States. Since then the number has greatly increased. For a time it was generally believed that the war would cripple the toy trade in Germany, and many persons in this country rushed into the business of making toys. As might have been expected many of these manufacturers through lack of capital or experience found themselves unable to compete with the older houses and were forced to drop out. On the other hand, a large number of them have been successful, and are turning out toys which make a distinct appeal to the American child. The war has had the effect of stimulating the toy trade in the United States, but it cannot be said to have caused the creation of a new industry.

Many of the best toys made in this country are not made by concerns which are given over exclusively to the manufacture of articles for the amusement of children. A manufacturer of stove bolts makes toy vehicles which are favorites with the children; some of the large publishing houses put out quantities of toy books; and a manufacturer who makes agricultural implements is also a manufacturer of toys. This peculiar condition makes it difficult to obtain an exact idea of the scope of the toy industry in the United States.

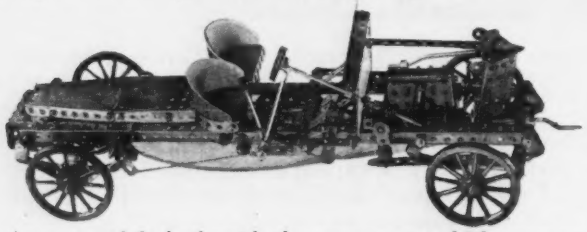
The American public spends about $40,000,000 a year on playthings for

children. More than half of this sum goes for toys made in this country. New York State leads in the number of toy manufacturers, although there are numbers of toy factories in many of the other States. After New York comes Pennsylvania, with Ohio a close third in the toy industry.

Next to the educational feature of the new toys is durability. There appears to be a veritable craze to attach the word unbreakable to the modern toy. From the man who sells dolls in the street and demonstrates their unbreakable quality by beating the sidewalk with the dolls' heads to the exclusive retailer who is too polite to adopt such direct methods, all sellers of toys endeavor to impress upon the purchaser that their toys will not break. The mechanical toys are generally made so they may be safely taken apart and put together again. It is not longer necessary to sacrifice the toy to gratify the child's curiosity. Where the toy is of such a nature that it is impossible to permit this the mechanism is protected by heavy casing made of steel or iron which is designed to stand anything short of the blows of a pile driver.



A sewing machine—the kind of toy which the modern child builds out of special parts

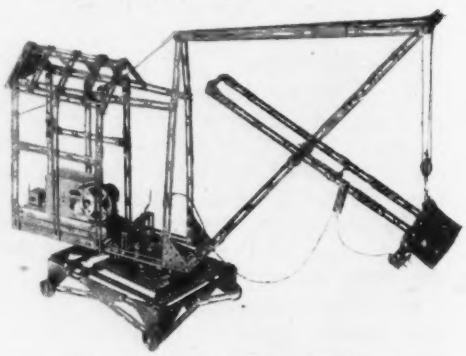


An automobile built with the same parts which compose the sewing machine shown at the top of this page

The war has had an effect on the type of toys which might be described as martial. There are many new war toys which have come into being in the past few months. Beginning at the top there are dirigibles, monoplanes, biplanes, hydroplanes; then getting down to earth and sea, there are rapid-fire guns, military automobiles, military equipment of all sorts, regiments of unbreakable soldiers who may be mowed down by machine guns; battleships, cruisers, and, lastly, submarines.

But with all their excellence and their harmlessness, military toys will never have the vogue that the construction toys have because the peace-at-any-price party will have none of them. There are numbers of people who think it nothing short of criminal to put a toy suggesting warfare into the hands of a child.

It is significant of the tendency of the times that the toys represent practically everything in mechanical engineering, in electrical and construction problems, but the agricultural toy is conspicuous by its absence. Our children may play at being wireless operators, at sinking battleships with torpedoes, at running a great railroad, but not at plowing a field.



A revolving steam shovel. The bucket is raised and lowered by means of a motor and emptied by pulling a cord. This is one of the latest operative construction toys

A Union Life Suit

One of the most novel life preservers yet offered to the public is the invention of O. A. Youngren, of Sheridan, Wyoming. Before a large gathering of prominent steamship men, Mr. Youngren recently donned his life saving union suit, dived into New York harbor, and disported in the chilly water until he had demonstrated the device to the complete satisfaction of the spectators. The union suit, which comprises the life preserver, is made of waterproof material, and is weighted at the feet with five-pound lead shot. This tends to bring the wearer into an upright position in the water. The buoyancy of the suit comes from a life belt of a special composition which lashes about the waist and over the shoulders. The entire device, ready for the water, weighs about fifteen pounds.

This life-saving union suit keeps clothes dry and also rescues the wearer from a watery grave. It is weighted at the bottom to keep the body upright, and is held up by life belts at waist and shoulders

Motor-Driven Coastwise Schooner

Shipbuilders on the Great Lakes have devised a type of ship which they claim will dominate the coastwise trade and displace both the modern coal steamer and the great schooners which carry so much of our coal.

This type is a steel-built, five-masted schooner, with a full spread of sail and also a powerful oil engine, so that it will be able to make fair speed in almost any sort of weather and save towage costs, which amount to thousands of dollars yearly for big vessels.

Blowing himself up

These auxiliary five-masters will be of about three thousand tons, fit for offshore as well as coastwise business. They are believed to be the most economical craft yet devised for general freighting.

Our exports of cotton yarn to Argentina during May, June and July of this year were nearly ten times as much as for the entire year 1914.

That Small Farm Tractor of Ford's

NEWSPAPER accounts of Henry Ford's plans for building a light farm tractor have stirred popular imagination to the point of picturing an immediate development as startling as that of the justly famous Ford car. However, it is doubtful that Mr. Ford entertains any such visionary ideas as the writers who are so thoughtfully interpreting his plans to the public. Until the fruit of his experimental work is put upon the market we can safely refrain from passing judgment upon his product.

Whether or not the tractor which is now being described and pictured can be established on the typical Ford scale is, however, worth a thought in passing. That section of the agricultural press which specializes on farm power machinery expresses its doubt in no uncertain terms, basing its opinion on an amazing procession of well designed small tractors which have failed to fit economically into the farm scheme.

This Ford tractor is not yet on sale, yet it is the best advertised tractor in the world

The conditions to be met are severe. The popular imagination which sees a light tractor as successful as a light motor car overlooks many vital factors. From the light car to the light tractor is a far greater step than from the automobile to the motor truck. The truck and the auto are built to carry; the tractor is built to pull. The load which helps to establish traction in one case is detached in the other, and upsets the parallel completely.

Taking round-wheel tractors as a class, four pounds of weight are required to overcome one pound of load resistance as measured by the dynamometer. A twelve-inch plow, cutting only six inches deep

Farmers are looking forward eagerly to the time when this experimental tractor of Ford's will be marketed

in the mellow loam of the Middle West, may have a draft as low as two hundred and fifty pounds, but is more apt to run three hundred and fifty to four hundred pounds. Two plows may easily overcome the ground-gripping power of a tractor weighing three thousand five hundred to four thousand pounds under very favorable circumstances. It is not so much a question of motor power as of ability to deliver a fair proportion of that power at the drawbar.

This mechanical problem is aggravated by the unfavorable surfaces over which the tractor must often travel—soft, rough, stony, and with frequent sharp changes in grade. The motor car has momentum to help it over the bad spots

in the road; the plow behind the tractor is a dead load. The automobile works at its maximum for short distances only; the tractor is normally loaded nearly to its limit.

The light car is justified largely on the score of pleasure and convenience. The tractor must pay a profit. The sale of a large quantity of light tractors at a low figure has already proved an easy matter. Some very good models, mechanically speaking, have been put out by reputable concerns of long experience in this field. But from an economic standpoint not one can be regarded as a distinguished success. Individuals, rather than a large class, have made them pay.

There is seemingly no logical parallel between the light motor car and the light tractor. Whether Mr. Ford will succeed in establishing one remains open to doubt. It will be well not to credit him with either success or failure until the farming public is invited to assist in the demonstration.

Hiding a Torpedo Boat With Stripes

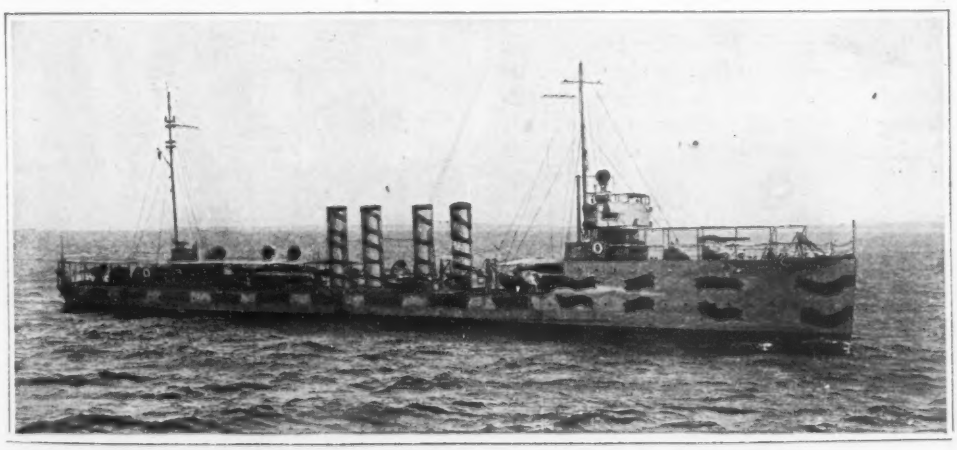
Many photographs have come from Europe showing ships, automobiles and guns painted with spots and splashes of many colors. When one is near these objects their vari-colored paint gives them a weird appearance, but when they are seen at a considerable distance the splashes of primary colors fade into the landscape or seascape and render them almost invisible.

Abbott Thayer, a prominent American artist, has devoted many years to a study of the colors of animals. He claims that each animal is colored by nature to protect itself against its own particular enemy. The zebra's coat is designed to confuse the enemy most dangerous to the zebra.

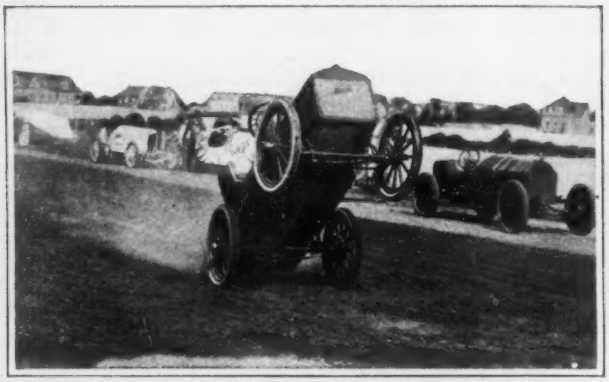
Working on these same lines Mr. Thayer says that it is a great mistake to paint our battleships a plain gray. Although the war paint is much more suitable than the white paint used before the Spanish-American War, even the gray color is visible at a great distance. To prove his point the artist obtained permission from the War Department to paint the torpedo boat destroyer *Patterson* according to his ideas. The illustration shows the result. Long, wavy lines on the gray war paint attract much attention when the slim ship is close at hand, but when she steams away from the observer she suddenly seems to disappear, as the wavy lines blend perfectly with the ripples and waves on the surface of the ocean.

Up the Rockies in High Gear

The publicity department of a prominent automobile concern announces that in the early spring, one of their twelve-cylinder cars will start on a transcontinental trip with all gears removed except high and reverse. It will have to cross the "Rockies," drive through mud and start from a dead stop—all on "high."



An artist, who is an expert on the coloration of animals, designed this scheme for concealing a torpedo boat on the surface of the water. At a distance, the stripes melt into the ripples of the sea, and the boat is lost to sight



Maud, the Motor Mule, can dance on her hind legs and spin in time to music

The Antics of Maud, the Motor Mule

An automobile that will run on its "hind legs," spin about, buck, and perform generally like the trick horse or mule of the circus has been the star feature of a number of race meets held in widely separated parts of the country. The car is known as "Maud, the Motor Mule."

"Maud's" athletic and adventurous talents are due to a heavy weight hung over her tail and to individual brakes on each rear wheel. The weight is heavy enough to overbalance the car. It runs easily on a little track projecting over the axle, and is concealed beneath a housing. The driver controls the position of the weight by means of a lever and is thus able to make the car buck as he wants it to.

When the car is reared on two wheels one of the independent brakes may be applied and one of the wheels locked, causing the car to spin around on that wheel. The band usually plays a waltz for this, and the driver, Roy Repp, manages to keep in time with the music.

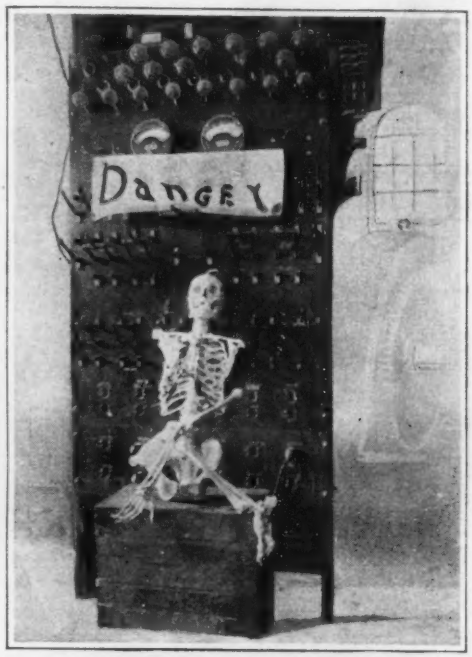
A Skeleton Danger Signal

The manager of an electrical plant, who was expecting to show a party of friends through the station, decided to avoid possible accidents by an unforgettable warning. He borrowed a skeleton from a friend, a surgeon, and placed it before the switchboard, where it would be the first thing to be seen. Above the grinning head a huge "Danger" sign was placed. On the arrival of the party, he made a few remarks about the fatal results of fingering the wires. His visitors were so much impressed that it is said they kept their hands in their pockets until they were safely outdoors again.

Death in Five-Sixteenths of an Inch

An English mechanic, employed in an aeroplane factory which is turning out flying machines for the British Government, was arrested and fined for wilfully cutting the propeller of an aeroplane five-sixteenths of an inch shorter than the standard length. It was alleged that he had done this act because of spite, since the firm would not release him for work elsewhere. It was stated that the life of an aviator would have been endangered if the defect had not been discovered.

A serious shortage in hardware goods has been reported from Sydney, Australia.



No one who passed this switchboard forgot the warning against handling wires or open switches

The Motorcycle as a Cart Horse

That the motorcycle has fields of opportunity yet unthought of was proved by a test to which one of them was put in Owatonna, Minn., recently. An expressman, whose horse was sick, appealed to the manager of a motorcycle agency, and the latter, wishing to acquire some publicity, offered the use of a motorcycle as a cart horse. A stock model machine was hitched between the shaft and hauled the express wagon to and from the different railroad stations with no trouble whatever.

The motorcycle makes a very satisfactory cart horse in an emergency

A Wirelessly Controlled Aerial Torpedo

A wirelessly controlled aeroplane torpedo, which may be discharged from an aeroplane and guided in its flight by a radio-instrument in the flying machine or on the ground, is the recent invention of George F. Russell, of East Orange, N. J.

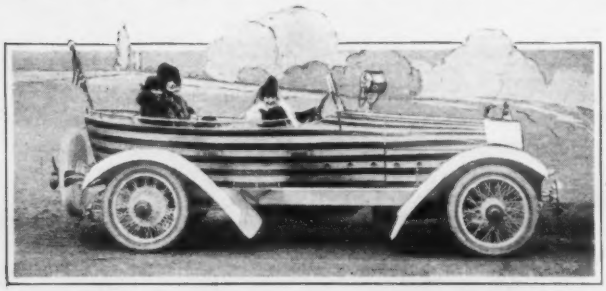
This aerial torpedo differs from most others which have been invented or suggested in that there is no motor by which it may be propelled, and that it must be launched from a height and left to glide to its target by means of its aeroplane wings.

The torpedo is made of aluminum and weighs but two hundred pounds. The model is seven feet and two inches long, twelve inches thick at the head, and five inches at the stern. It weighs but fifty pounds without the explosive.

When the projectile is released from the aeroplane, it will glide down swiftly. The course of the missile is easy to follow, even at night, for in the stern is a large electric light which will be constantly visible to the sender. A small governor is controlled by a mechanism in the forward compartment of the torpedo, and prevents the discharge of the explosive until it has gone several hundred feet on its downward flight. After that, it will discharge at the slightest contact.

Dozens of patents have been taken out on wirelessly controlled aerial torpedoes but not one of them is in use.

An aerial torpedo which can be actually controlled in its flight by wireless from an aeroplane or from the ground. The torpedo weighs two hundred pounds and is made of aluminum. It is exploded on contact with a solid object



The lines and workmanship of a racing boat were incorporated into the making of this automobile

A Motor Car with a Boat Body

One of the most freakish cars ever seen in New York has recently been displayed in an automobile manufacturer's show-window. The body resembles a modern motor boat and is built of alternate strips of mahogany and white holly, while the deck is finished in bird's-eye maple. All the deck and body fittings are finished in nickel, and the upholstery is of pigskin. On the rear portion of the circular radiator is a silver eagle with outstretched wings, while forward of this is a ship's bell, also finished in silver.

The entire body is harmonious, and the resemblance to a watercraft is truly remarkable. The strange body was fitted to a stock chassis, and is occasionally driven on the street, never failing to attract much attention.

Cement Makes a Solid Advertisement

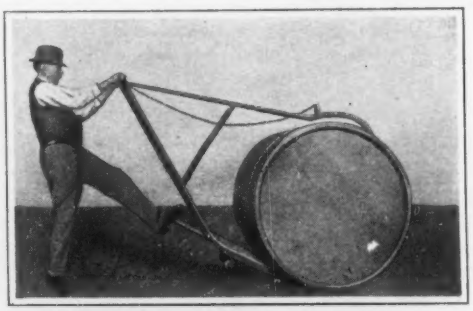
A novel use for cement was made in building the culvert sign shown in the photograph. This stationary advertiser is located upon a tract of land a short distance north of Los Angeles, California, for Southern California is the home of original methods of advertising real estate.

A concrete real estate sign can be ornamental as well as indestructible

Letters two feet in height, six inches in thickness and a foot wide, which form the name of the tract upon which they were located, were cast and so placed as to form a support for the railing which ran across the entire width of the culvert. This culvert, containing the street name, is situated on a main state highway. With the exception of the railing running across the top the culvert is finished in rubble effect, while the railing, which is six inches thick and a foot wide, is finished smoothly.

One Man Handles a Thousand-Pound Hogshead

A hand-truck newly invented, by Benjamin V. Harvey and Basil K. Watkins, Danville, Virginia, has made it possible for one man to load and transport heavy hogsheads. The man shown in the illustration is taking up a hogshead of tobacco weighing one thousand pounds. The most difficult part of the work, which is the loading, is made possible by the provision of longitudinal runners extending out to the end of the truck, the rounded ends of which afford an effective leverage. At the same time the hook which extends over the top of the truck has its point engaging the further side of the hogshead to prevent it from rolling off.



By ingeniously applying the principle of the lever it is possible for one man to handle one thousand-pound hogsheads with this truck

Moving Houses to Escape Ocean Breakers

By Robert G. Skerrett

PROPERTY owners along certain sections of our Atlantic coast are wisely realizing that it is well nigh useless to try to battle with stormy seas. This is particularly the case on the New Jersey coast reaching southward from Sandy Hook for scores of miles. Many thousands of dollars have been spent in years past in building bulkheads or in running jetties out from the shore to arrest the destructive wash of storm-tossed breakers, but almost without exception the Atlantic Ocean has had its way in the long run. Cottages built on the crest just above the beach line have been repeatedly undermined, and this meant either abandonment or the bodily retreat of the buildings.

Moving a large house on a pontoon across a stretch of open water

This situation has stimulated the business of the house mover, but it has also developed phases of the craft not commonly met. It is no unusual thing the country over to see frame houses shifted from one site to another, but, as a rule, these transfers are matters of only a short distance and, generally, the structures are of modest dimensions. The house mover on the peninsula south of Sandy Hook has had harder tasks than these to battle with, and the transplanting of the cottages has not been confined alone to overland journeys. Indeed, some of these buildings—the very biggest of them—have had to make water trips in order to reach their new locations, and this sort of voyaging has taxed the cunning of the house mover to the utmost.

The storm-swept surf has played havoc with ocean-front cottages

Some of the cottagers have moved their summer homes hundreds of feet north or south beyond these low areas while shifting back from the ocean front as well. The wiser property owners are crossing the Shrewsbury River, and planting their houses anew on the mainland far above the reach of the highest tide.

Another house being transported across the bay. (Center) Wreckage caused by autumn storms

Sixty-Million-Candlepower Searchlight

A new motor truck equipped with a searchlight developing sixty million candle power, has recently been adopted by the Italian Government. The searchlight itself is equipped with a small carriage fitted with wheels and rollers, so that it may easily be dismounted and operated at a distance from the motor car that furnishes the power.

The searchlight has a glass parabolic mirror fitted to a frame which may be easily removed. It is artificially cooled by a small electric fan, this guaranteeing a long life to the silvered surface of the mirror. A blind signal device is fitted to the front of the searchlight, so that the light may be used for signaling at great distances. When the iris is shut in front of the light the plant is invisible at night at only a few yards distance, even with the searchlight working within at full power.

This new army searchlight develops sixty million candlepower

The Booming Cork Leg Industry

An industry which has been practically dormant in the past but which is now growing by leaps and bounds is the manufacture of false arms and legs. One American concern is said to have received already orders from the French and English Governments to the extent of fifteen million dollars. The normal producing capacity of this concern is two hundred and fifty artificial legs a month, and it is planned to have its output multiplied five times in the near future.

The strength of the rope is accurately ascertained inch by inch by putting it to the test of an actual strain

How Strong is the Rope?

The question of whether the rope will stand the strain can now be answered before the accident occurs, and is doing much to prevent unfortunate mishaps to men who risk their lives on scaffolds, tall chimneys, mines and elevator shafts.

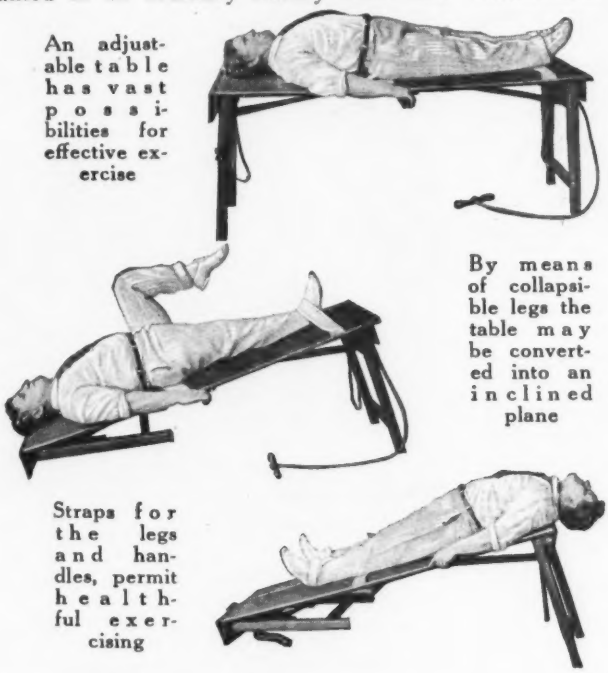
Through the perfection of a rope-testing machine precisely how much strain a rope will stand can be accurately recorded. The tester is motor driven, and carries the rope over a series of grooved pulleys while the pressure is applied by hand power working through pulley and gears. No matter how long the rope may be, the same tension is applied to every inch of it, thoroughly testing it for reliability.

The tension as applied to the rope is indicated by a scale located near the operator. As the material under test passes from the pulleys it is caught and wound upon a reel ready to be removed and tagged. The rope is in no way weakened and its ability to come up to its full specifications is determined by its actually doing so.

The test of rope for strain will not, however, affect the life of a rope of steel or hemp which must end a day before it wears out.

This Adjustable Table Makes Home Exercise Convenient

It was Dr. S. Weir Mitchell, the great Philadelphia nerve specialist and author, who first pointed out the vast possibilities for effective exercise which were contained in an ordinary library table and two feather pillows. His patients were taught the principles of exercise at home on the table in Dr. Mitchell's office, and many traced their rejuvenated nerves very largely to the formulas of exercise which he taught them. The superintendent of a middle western sanitarium has devised an adaptation of Dr. Mitchell's scheme, in a table which is adjustable to all angles and is fitted with additional appliances.



An adjustable table has vast possibilities for effective exercise

By means of collapsible legs the table may be converted into an inclined plane

Straps for the legs and handles, permit healthful exercising

The table in its natural position affords opportunity for leg lifting, trunk exercise and many other forms of physical training. Through the adjustment of the supports the table may be converted into an inclined plane for other forms of exercise.

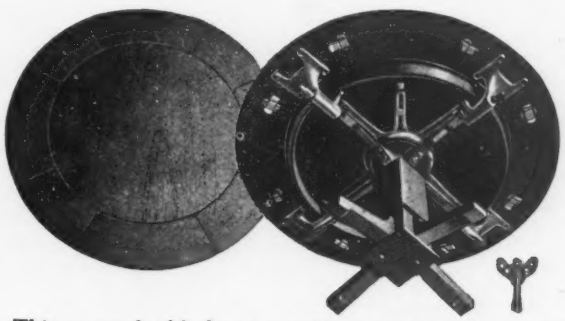
Straps across the table beneath which the feet may be thrust, two handles at a convenient position on either side, and a cord with a handle are some of the simple additions to the table which render it extremely valuable for the work for which it was designed.

Spin the Table to Get Salt and Pepper

A dining room table with a revolving center and with the extension leaves of segment form adapted to latch together, has been invented by two Washington men. The extension leaves are held in rigid position by four arms extending from the central supporting post of the table. A turn of the locking lever fastens together one of these arms and the corresponding bracket which supports the extended leaf. The central portion of the table has a depending stud which fits in a pocket in the central post, and the table is made easily revolvable by supporting it on ball bearers in a race beneath the table.

To pass the salt on this table, it is only necessary to give the revolving centerpiece a spin half around to bring an article from across the table to a point directly in front of the person who wants it. Meanwhile the segmented leaves or outer portion of the table remains stationary.

Two hundred and fifty million dollars were spent on state highways last year.



This unusual table has a revolving center and segment leaves latched together

Motion Photography at Night in Inaccessible Places

For some time motion picture directors have felt the need of some apparatus that would enable them to utilize for night photography locations that are so far from the source of electric power as to make it impracticable to stretch wires for lighting purposes. This problem has recently been solved by Romaine Fielding, formerly a "movie" star and now feature director of one of the large companies. He has devised an independent travelling power plant that will make possible night motion photography in many inaccessible places where artificial light has hitherto been unknown.

The portable thirty-five horse-power plant, which was constructed in accordance with Mr. Fielding's ideas and is his own personal property, besides providing apparatus for running wires, is equipped with a powerful twelve-inch navy searchlight of the projector type. This light is mounted on the seat beside the driver and may be operated either while the car is moving or standing still. The capacity of the searchlight is four and a half million candle power. When in operation it requires twenty-five per cent of the full power of the plant. Mr. Fielding is staging pictures in the Grand Canyon of Arizona, and with this powerful searchlight expects to delve into the depths of the caverns of the great crevasse and to utilize for locations the dark recesses, caves and trails. This will be the first time that the marvellously beautiful scenery of the canyon has served as a nocturnal setting for the pictured drama.

This portable plant makes possible night motion picture photography in spots to which electric light wires cannot be strung

Through Jonah's Gateway

Gates have been made of many materials, but the one shown here was constructed from the jawbones of a whale. The jawbones, which bend inward at the top, pass through two concrete blocks, and are then sunk six feet in the ground as well. Hence they are almost thirty feet long.

Enter and pass, Jonah-like, through the jaws of a whale

This entrance to an estate in St. Johns, Newfoundland, has been in use for over seventy years, and is still in perfect condition.

Stray Steers Cause Discovery of Cinnabar Deposits

Two prospectors, trailing some stray steers in western Nevada, found that the tracks led over an old prospect in which a face of red mineral was exposed. One of the men recognized the mineral as cinnabar. Returning to the spot a few days later, the two miners spent ten days and located seventeen claims. When they returned to the town of Mina, Nev., and made known their find, nearly every man in the village rushed to the spot and staked off claims. It is from cinnabar that mercury or "quicksilver" is obtained, and the field thus discovered is likely to be profitable.

Kitchen Cabinet Can Be Adjusted in Height to Suit the Worker

A kitchen cabinet has recently been perfected, which can be changed to the correct height for either the very tall or the very short woman. A simple turn of a crank, placed conveniently at the right

A simple turn of the crank raises or lowers the kitchen cabinet to suit the short or tall housewife

hand corner, will raise or lower it to the correct height. The top of the cabinet base telescopes the lower part as the table is lowered, and a ratchet holds it in the proper place.

There are additional novel features about the cabinet, among which are the sliding doors in the upper section. These doors may be opened and closed without removing any articles from the table top. The sugar jar is equipped with an automatic valve, which opens with the pressure of a cup, and closes when the pressure is released. The coffee dispenser at the left of the sugar jar has a sliding compartment underneath, which enables one to obtain a heaping tablespoon of coffee at a time, thus measuring it without the aid of a spoon. The two long shelves, the full width of the cabinet, are an especially economic arrangement, as most cabinets have narrow divided shelves.

Germany Wants American Feature Films

A report recently issued by the American Association of Commerce and Trade in Berlin states that notwithstanding the war, the improvement in motion picture film production has steadily been progressing, and that the German film today is in every sense much better than before the war. A poll among a large number of leading members of the German film industry indicates that the American film is well liked, although little information can be gained in Germany as to the American feature film. The report states that there should be a big field in Germany for a progressive producer of features if he should secure an experienced representative in Berlin and furnish him with a negative film to secure prompt deliveries of positives. The association invites American producers to avail themselves of the services of that body in securing proper representation.

How Uncle Sam Shears His Horses

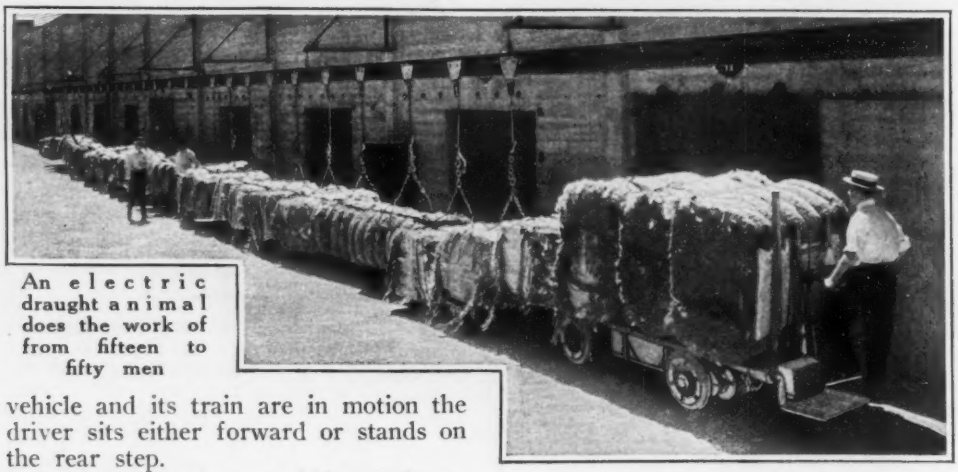
The accompanying photograph shows how Uncle Sam employs mechanical means for clipping horses. It must be remembered that these patient, hard-worked animals are required to look as neat and trim as their masters; and the picture shows a trooper at Fort Thomas, Ohio, shearing his horse with the aid of a pneumatic device, in which the air is compressed by turning the handle of the apparatus. Rapid and neat work is assured by this device, and the operator is not so quickly fatigued as with the old hand shears.

Clipping an army horse with air

The Electric Mule

Unlike the Missouri mule which was never known to have but one speed, and that sometimes backward, the electric mule has six speeds, four ahead and two reverse. It is built in three and four wheeled types. It has steel framework and solid rubber tires on its wheels. It varies in weight from two to eight tons.

The new electric mule can handle a dozen or more of the old-style four-wheeled trucks if they are equipped with couplings and links so they may be hooked up to the tractor. When this vehicle and its train are in motion the driver sits either forward or stands on the rear step.



An electric draught animal does the work of from fifteen to fifty men

On the great wharves of New Orleans, Savannah and Galveston, it is no longer an uncommon sight to see a storage battery tractor hauling a train of ten or twelve trailer cars all loaded with cotton. The modern electric mule does the work of from fifteen to fifty men. While the trailer decks are being loaded the tractor is usually employed hauling other trailers, which are ready for trains, from the railroad terminals to the docks and sometimes even into the holds of transatlantic steamers.

Earthquakes Caused by Big Guns

Among the interesting scientific suggestions that the war has called forth is the proposal to use the seismograph, an instrument for recording earthquake-vibrations, as a registering apparatus for studying the vibrations caused by artillery firing. During the recent fighting between Italy and Austria on the Isonzo, a river flowing into the Gulf of Trieste, the sound of the cannon was heard at Laibach, an Austrian city some fifty miles distant. A very sensitive seismograph in the station for registering earthquakes at Laibach traced a record of the shaking of the ground from the batteries in action during the second battle of Görz on the Isonzo.

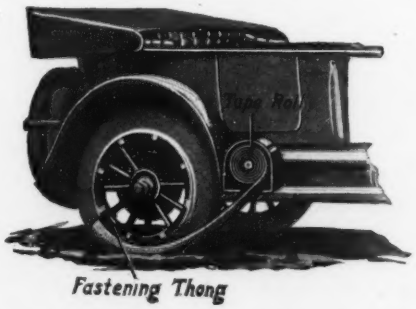
The chief of this earthquake-station, a school-inspector named Belar, proposed to the military authorities as long ago as 1907 to make experiments in recording the vibrations caused by the firing during the summer artillery practice. Seismographs were placed at different distances from the ordnance and the tracings they made were compared.

A perceptible contrast was noticed between the line made by the firing of cannon and that arising from the discharge of mortars. The vibration resulting from the recoil after the firing of cannon made a line of short waves; the explosion of a shell produced a longitudinal wave-movement.

Professor Belar has sought to make a collection of tracings sufficiently large to establish a table of reference from which, he believes, a large amount of information about cannon heard at a distance could be deduced, including the direction, number and calibre of the guns, and whether friend or foe was firing. An interesting point proved by his tracings is that the recoil of a gun-barrel produces a vibration scarcely less than that arising from the recoil of the old gun-carriage.

To Help Autoists Out of Ruts

Automobile tourists and drivers of long-haul motor trucks will find joy and relief in a new and simple device for enabling a vehicle to pull out of a rut



Fastening thongs are secured to the spokes and canvas tape is drawn under the wheel, thus presenting a firm, dry surface for the tire to ride upon. Thus the autoist is helped out of ruts

or a mud-hole on its own power. Whereas formerly the driver of a ditched automobile was confronted with the annoying necessity of running to the nearest barn for a plank or a pole with which to extricate his car from a mud-hole, the new device is so small and compact that automobilists can carry the means of their deliverance right under the running board of the car.

A glance at the illustration shows how essentially simple this new accessory is. A strong tape of very tough texture, preferably of canvas or fiber paper, and of a width slightly exceeding that of the tires, is wound upon a reel contained in a small metal case fastened beneath the running board. Attached to the free end of the tape, which may be of any desired suitable length, say fifteen yards, are two stout leather thongs or cords strong and flexible enough to be tied and untied many times.

With this device the motorist who might otherwise find the pleasures of a tour marred by a mud-hole or a rut can easily liberate his car. The two thongs are drawn out, fastened securely to a spoke of the imprisoned wheel and the power applied. As the canvas or fiber tape is thereby gradually drawn under the wheel, a firm, dry surface is presented to the tire, which grips the tape and easily emerges from the rut.

Showering Gifts from the Sky

A feat in advertising was recently performed at Atlantic City, N. J. An aeroplane flew over the crowded board walk, and dropped boxes of cigarettes on the heads of the promenaders.

Listening to Birds' Table Talk

On the lawn of an English country house, the cats never permitted robins and finches to gather up the crumbs thrown by the little chap in the picture. Accordingly, the lad's father erected a cat-proof tray on a tall pole, and added to the tray an ordinary telephone transmitter protected by a brightly painted tin can.

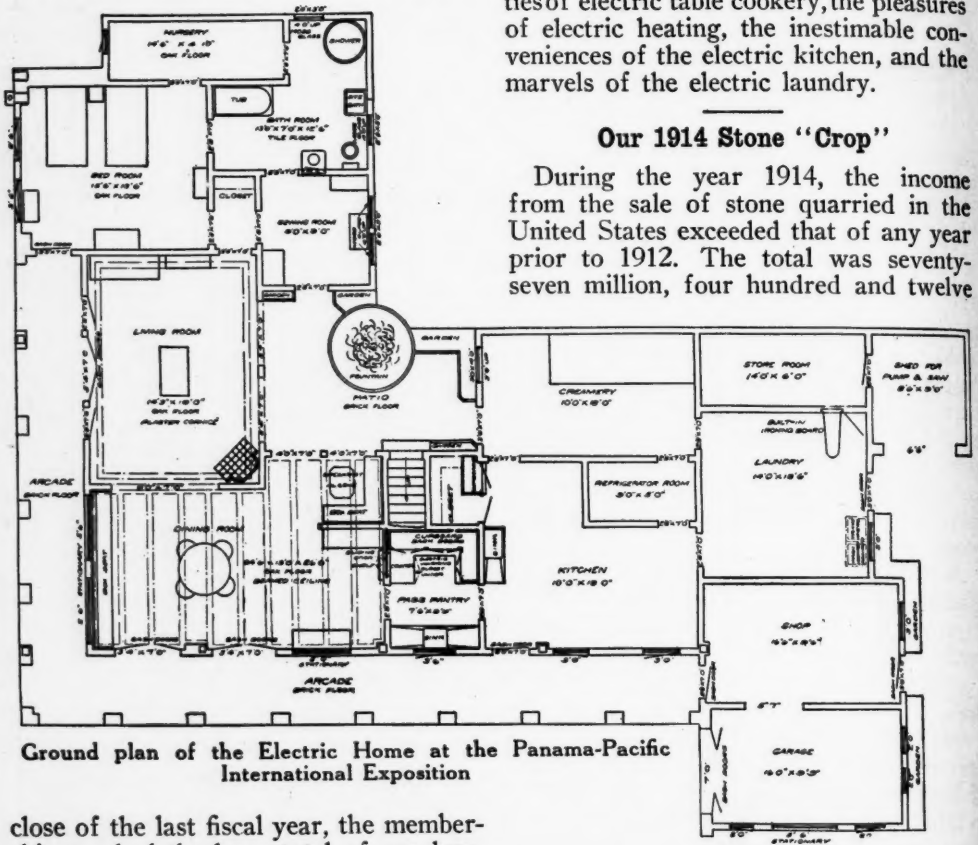
When the hungry birds gathered for a feast on this tray, their chirping and singing were plainly carried to a receiver located in the house.

When hungry birds gather in the tray, their chirping is carried by telephone to a distant house

Agricultural Clubs for Boys and Girls

There has been an increase of more than forty-one thousand in the membership of various boys' and girls' agricultural clubs conducted by the State Agricultural Colleges and the Department of Agriculture in the northern and western states. At the close of the last fiscal year, there were one hundred and ten thousand and seventy-seven members in the various club projects in the thirty-three states covered by this work. At the close of the last fiscal year, the membership reached the huge total of one hundred and fifty-one thousand, one hundred and ninety-four.

Members have their attention directed to problems of farm and home management, crop rotation, soil building, etc., and a large number of club members are now working out three and four-year rotations of crops. The profits which they derive from club work they are spending on getting an education, or for purchase of pure-bred stock and labor-saving machinery. Many are even buying land.



Ground plan of the Electric Home at the Panama-Pacific International Exposition

The Home Electrical and Practical

One of the features of the Panama-Pacific International Exposition which had a popularity surprising even to its producers was the "Home Electrical." A California stucco bungalow was built within one of the great exhibition buildings. In the attractive surroundings of home, the newest electrical appliances which have been produced to make modern housekeeping easy were laid out.

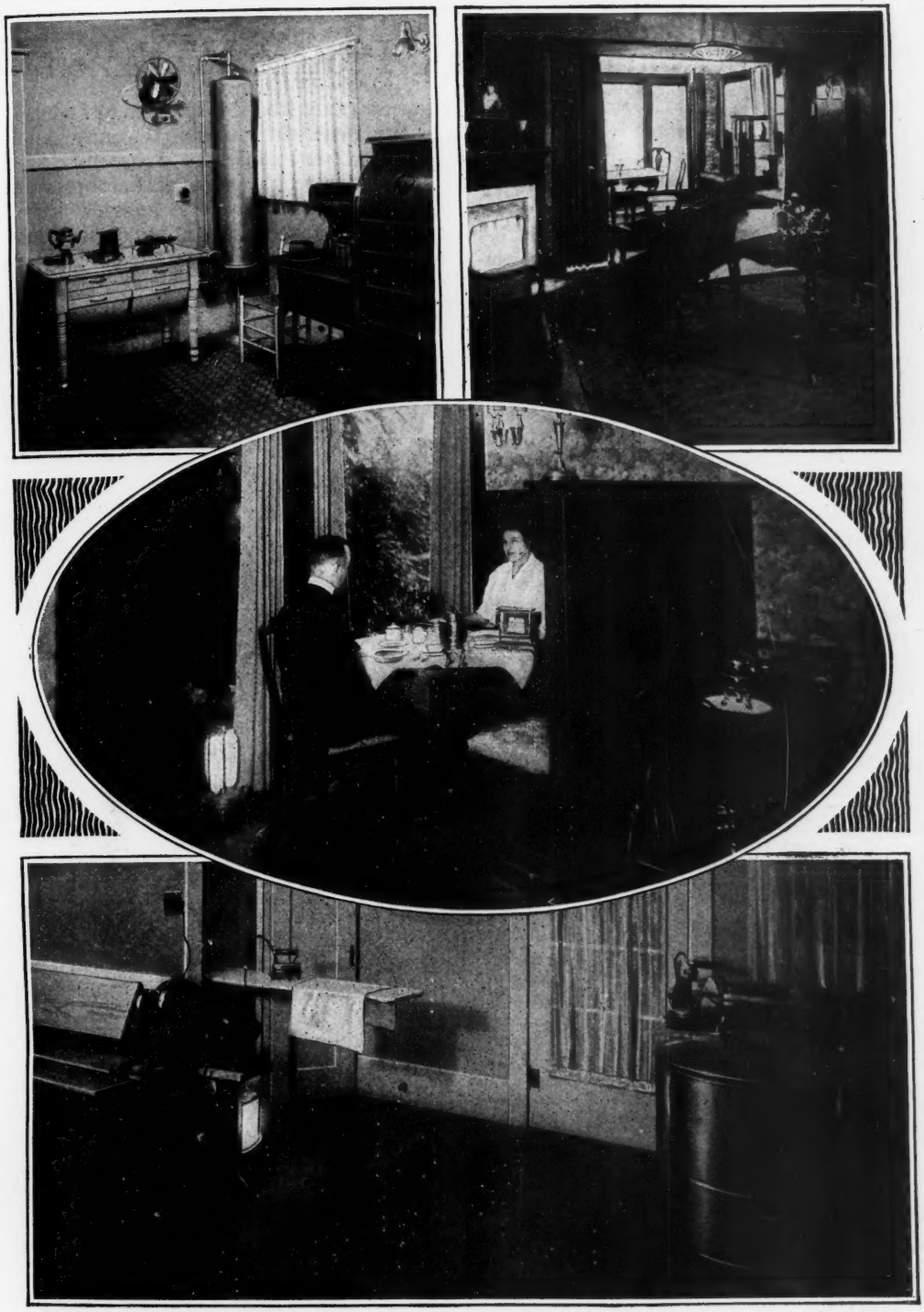
Here the visitor learned all the niceties of electric table cookery, the pleasures of electric heating, the inestimable conveniences of the electric kitchen, and the marvels of the electric laundry.

Our 1914 Stone "Crop"

During the year 1914, the income from the sale of stone quarried in the United States exceeded that of any year prior to 1912. The total was seventy-seven million, four hundred and twelve thousand, two hundred and ninety-two dollars, a falling off of a few per cent. from the income of the two previous years.

The sale of granite made up more than a fourth of the total. Monumental stones represented only one-tenth, the remainder being divided among sand stone, paving stone, curbstone and miscellany.

Pennsylvania out-distanced all other states, as it has in every previous year, except 1908.



The sootless, electric kitchen. The rosy grate and indirect light, electric comforts of the modern living-room (upper right-hand corner). The breakfasts of an ever-increasing proportion of Americans are now made feasts of daintiness by the magic of electric table cookery (center). More drudgery has been eliminated by the electrical home laundry (lower cut) than by any other scientific achievement

Appliances and Clothing Protect Workmen

The sand-blast worker wears a respirator

THE use of proper clothing to prevent injury is a phase of the "Safety First" Campaign that is being vigorously pushed by the National Founders' Association in an endeavor to cut down the number of accidents occurring in foundries.

Much attention is paid to the clothing which should be worn by the molten metal workers who are in constant danger of being splashed by the fiery liquid which they handle. In many foundries, burns of the feet and legs have been almost completely eliminated by the use of proper clothing. Heavy shoes, leggings of stout canvas and woolen trousers, turned down at the bottom, form an admirable combination.

Goggles and leather boots in molten metal work

Gloves and sleeve rings are important

Leather gloves are part of the equipment of the men handling hot or raw cast metal in the modern foundry

For severe heat conditions around furnaces and ovens, furnacemen often require gloves for their hands and arms. Calfskin or buckskin gloves usually answer the purpose, but in some cases asbestos must be used.

Injury to the eyes of foundry employees, caused by the splashing of metal or the flying of chips in cleaning and grinding operations, are frequently severe, often resulting in partial or even total blindness. Safety goggles have caused a marked diminution of injuries to the eye, in shops where they are worn by all employees while engaged in handling molten metal.

Men who handle pig iron, scrap and rough or hot castings are greatly benefited by suitable hand leathers or gloves. A form of hand leather that has proved quite acceptable is composed of two pieces of heavy leather cut to the general shape of the hand and fastened together at the wrist by elastic goring similar to that used in foundry shoes.

The dangers encountered in dusty occupations, unless carefully provided against, may injuriously affect the health of employees engaged in such work. In many instances the employees do not realize the

Helmets are now used in heavy sand-blast work

dangers and the necessity of preserving their health, and accordingly they do not take advantage of the safety devices provided by their employers for their protection. Helmets and respirators are usually furnished for the use of sand blasters, but they are too often disregarded by the workmen. Unless the helmets are used and the respirators kept moist, the men run grave danger of contracting lung trouble of an especially serious and chronic nature.

Non-inflammable clothing is used in work near furnaces

Emphasis is placed by the association upon the need of keeping the clothing in good repair, so that loose belts, torn gloves, dangling sleeves and other pieces of clothing do not catch in the machinery. Many injuries caused by contact of moving machinery with finger rings worn by mechanics have been reported. Such rings should not be worn by workmen where a hazard of this kind exists.

The workmen are being constantly reminded that the cautious way of doing their work is the safe way, and that safety appliances not only protect them but also serve to render their work easier and their labor more efficient.

American Aviators with French Army

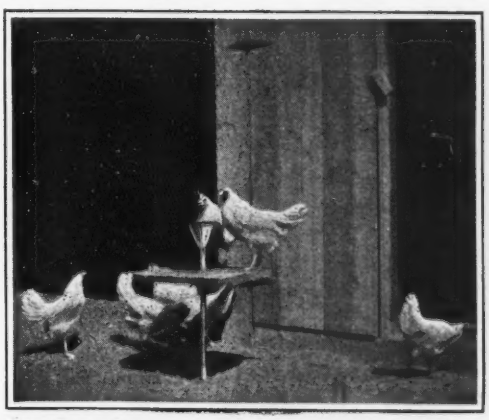
An aero corps composed entirely of American aviators is now at work with the French Army. For several months the corps has been practicing at Pau, and by this time is probably in actual service at the front.

Some of the well-known Americans composing the corps are Norman Prince, Elliot Cowden, James Bach, Frazier Curtis, H. G. Guerin, Burt Hall, Didier Masson, Charles Weyman and William Thaw. The detachment has, beside the aeroplanes, a number of motor cars and trucks, motorcycles and a staff of mechanics. All of these are operated by Americans, most of whom were living on the Continent when the war broke out. It is said that several members of the American Ambulance have joined the new flying corps.

These Hens Must Exercise for a Drink

A prominent poultryman in Tecoma, Nevada, has devised an unusual set of elevated water fountains which require the poultry to fly up to them to satisfy their thirst. This gives them the needed exercise to keep them well and to make them lay well. The conical cups from which they drink are narrow and sufficiently raised above the platform or perch so that the hens cannot climb in and foul the water. The rapidity with which the hens learn to use it is remarkable.

Running water is constantly supplied to the various fountains by pipes which are laid underground. An elevated loop in the pipe keeps the water in the fountains at a uniform level, and in the winter warm water is used, so that there is no danger of fire from the use of water fountain lamps.



The hens have to use their wings when they want a drink

A New Way of Sharpening Used Safety Razor Blades

The unsatisfactory character of the edges of resharpened safety razor blades is a source of annoyance to home shavers. The reason is that all the machines used for resharpening blades do their work either by honing on a flat leather carborundum surface, or by flopping it between two sharpening rollers. The result of this treatment is to wear the blade down, and as the ordinary blade is made to project past the guard only a very short distance, after a few sharpenings the blade is so worn away as to become useless. Moreover, the edge is round and blunt when treated in this way.

With the new device shown in the illustration, the blades are clamped in a holder and inserted in the machine between revolving cylinders. The holder moves backwards and forwards while the cylinders are revolving, and the blades are edged by even pressure applied to both sides. This puts a concave edge on the blades, as seen in the diagram, without wearing the blades down. They can thus be re-edged over one hundred times, and will still be of the same width and will shave as well as when new. A one-quarter horse power motor drives the machine at a speed sufficient to edge seven blades in sixty seconds.

A safety razor sharpener which gives a hollow edge to old blades. The blades are clamped in a holder and inserted in the machine between revolving cylinders. They are edged by even pressure applied on both sides by perfectly regulated mechanism

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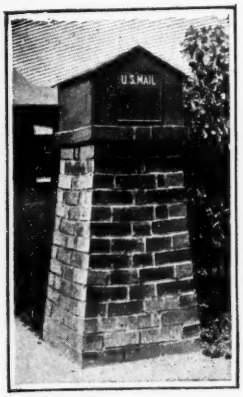
Quick Trestle Building in the West

A three hundred and fifty-foot tunnel on the Southern Pacific Railway was closed to traffic last May owing to a cave-in when a fire destroyed some of the timbering. Since the tunnel could not be reopened for some time, it was decided to build a temporary line around the shoulder of the mountain. A trestle, four hundred and sixty feet long and sixty feet high at the highest point, was completed in nine days and nine hours from the time the material was ordered by telegraph from Oakland, three hundred and fifty miles away. The entire temporary line was completed in nineteen and one-half days.

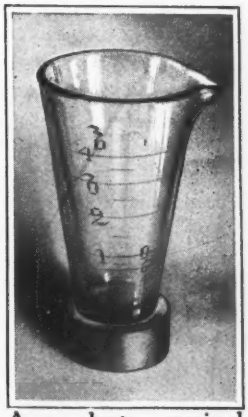
A Bungalow Mail Box



A mail box on a special built pier

The question of a suitable mail receiver is one which comes to every home owner and which is not the easiest one in the world for the owner of the country or suburban place to answer. In the accompanying illustration is shown a combined receiver and pedestal which is at the same time serviceable and attractive. This pedestal is made entirely of red brick, with the exception of the mortar, which is of a light-gray color. The little "bungalow" mail box is made of sheet copper. The pier is about three and a half feet in height and two feet in width at the base. This feature is in entire harmony with the home before which it stands, which is composed of brick and which has hammered-copper hardware.

Repairing Measuring Glasses



A guaduate repaired with a plaster of Paris base

On account of the thin, slender base of the usual form of graduates used for photographic, cooking and medicinal purposes, the graduates are very easily broken. The lid from a tin baking-powder can, filled with a fairly thick mixture of the white of an egg and plaster of Paris will mend the rugged edges of the broken base when firmly pressed into the plaster mixture. After being left in a warm place over night the base will be practically as solid as stone, and will stay in the same condition for several years. The same cement used for this purpose also makes an excellent cement for other articles of glass where a neat mass of plaster will not spoil them for use.

Pasteurizing Milk for Babies at Home

A milk pasteurizer built like a double boiler

A new pasteurizer, which is built on the principle of a double boiler, is a sure and safe method for destroying harmful bacteria in milk. It is much like an ordinary large coffee pot except that the flat top has holes large enough for bottles, and the inner receptacle is made up of tubes large enough in diameter to contain the bottles. The outer kettle is filled with water by means of a funnel placed in one of the openings in the top. After the water is boiling, the milk is completely sterilized in a few minutes. No thermometer is needed, as the double-boiler principle makes the heat control automatic.

Lighthouse Street Lights

A lamp post built like a lighthouse

The street lights of one of the pretty residence districts of Berkeley, Cal., are of rough granite, and stand about twelve feet high. They are round pillars, and are capped with a block of cement, upon which rests a large lantern of bronze and glass. A seat of cement runs around the post near the ground, for a resting place. These lamp posts were designed to suggest the appearance of a lighthouse. The effect is pleasingly nautical.

Ironing Board Troubles Are Over

A device for holding covers on ironing boards has recently been invented. It consists of a set of six clips, which are screwed a certain distance apart in the center of the ironing board. These clips have two claws at both ends to hold the cover securely to the board. The claws are shallow and do not harm the fabric.

The clips hold the ironing board cover securely

When it is desired to remove the cover, the claws may be lifted and the cloth carefully drawn out from between the teeth of the clips and the board. When the six clips are used the cover must lap over the board four or five inches on each side, but for the twelve-clip set the cloth needs to lap by an inch or two. By using the clips, covers for the ironing board are not torn as they are when tacked on.

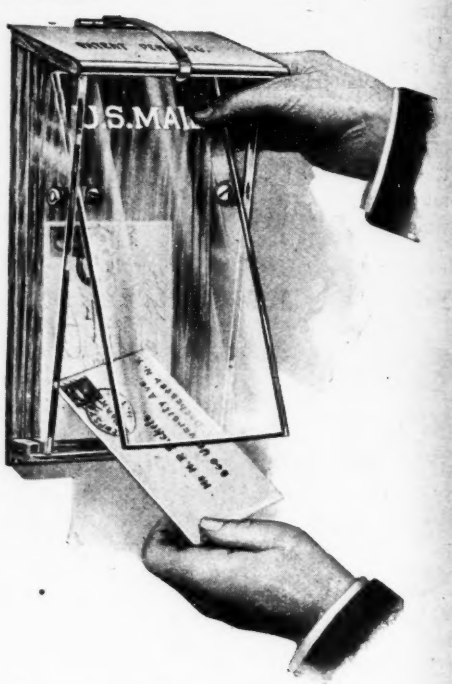
Aluminum the Most Abundant Metal

Aluminum is the most abundant of all the metals. In its various forms it constitutes about fifteen per cent. of the earth's crust, according to the United States Geological Survey. A few years ago it was a curiosity, and its value was fourteen or fifteen dollars a pound. At present it is selling at about twenty cents a pound.

Already aluminum has displaced steel in certain classes of construction where strength is required in combination with extreme lightness, such as in the manufacture of flying machines. An alloy known as duraluminum, containing about ninety-five per cent. of aluminum, is claimed to be as good as Bessemer steel for some purposes, although it is only one-third as heavy. This alloy possesses great hardness when annealed, and its melting point is above one thousand, two hundred degrees Fahrenheit.

A Mail Box of Plate Glass

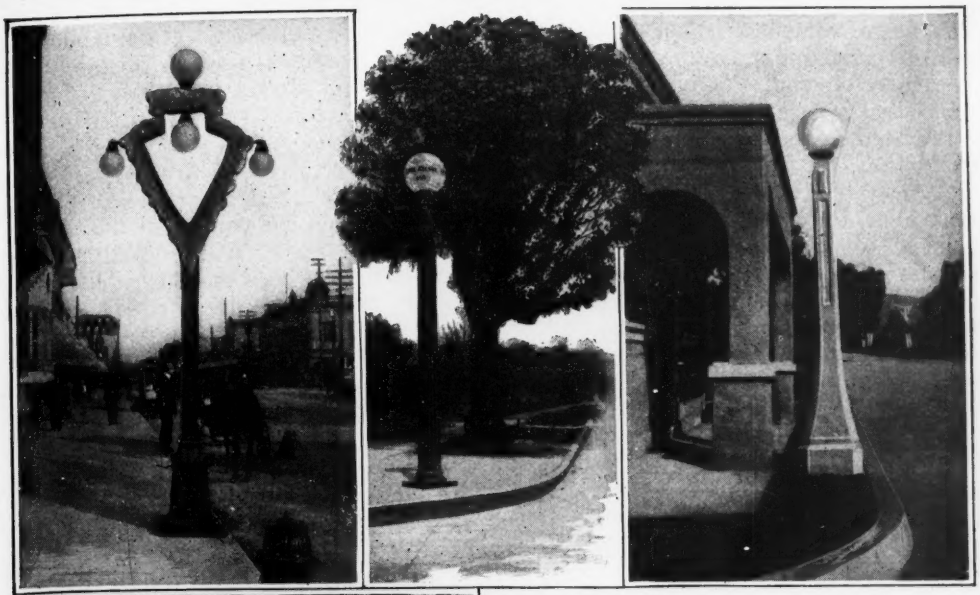
A new mail box for the home has recently been invented which is made of glass, and the contents are therefore always in view. It is made of plate glass, with a nickel top, and kiln-dried wood. The boxes are made to match the wood of any door or casing, and therefore are more ornamental than the old painted tin ones. The mail is put in the slit just under the nickel top, and taken out at the bottom. By pushing the upper part of the glass front it is made to swing in, and one may then reach in at the bottom for the mail. This operation is provided for by means of nickel-plated brass patent pivots, about a third of the way from the top. For those who do not desire a plain glass, a ground glass is also made, which makes the contents sufficiently visible, but does not allow the addresses on the letters to be read.



Mail may be easily removed from this transparent letter box

Natural Gas in the United States.

The production of natural gas in the United States for the year of 1914 amounted to more than five hundred billion cubic feet. This record breaks all previous ones by ten billion cubic feet.



Names of streets are sometimes lettered on the white glass shades of these attractive street lights

Cross and bell-like lights typical of mission California. Above, arrowhead lights at Riverside

What Electricity Has Done for California Street Lights

By Albert Marple

Novelty reigns supreme among the street lighting fixtures of the various municipalities of Southern California. It would seem that during the past few months the cities of that section have been trying to outdo one another in the presentation of the unusual, which is at the same time something practical.

Streets illuminated by oil or gas lamps in large glass cases were, in the good old days, of about as many different designs as there were cities. With the use of electricity soon came the "arc" light, hung above the center of the street, still in general use. Now, however, the popular device is the more beautiful electrolier, the wires connecting which are run underground. These electroliers contain from one to a dozen lights and are of thousands of shapes and designs. They are made of both iron and cement, the latter form of material having grown rapidly in popularity in California during the past few years.

Many of the cities of Southern California have titles other than their original names. For instance, Alhambra is called the "Crescent City," Los Angeles the "Angel City," Pasadena called "The Crown City," Riverside "The Arrow City," and so on. In many of these cities the electroliers have been designed so as to carry out the city's nickname. This is shown in the arrowhead feature at Riverside. The cross and bell-like white glass shades are typical of old Spanish missions, some of which are still in existence in that section. With the exception of the lights the entire elec-

trolier is of cement. This nickname idea is also carried out in the cement and steel electrolier at Alhambra, the "Crescent City," where a crescent has been incorporated in the steel part of the electroliers.

A new idea, that of numbering the electrolier to correspond to the street number of the house before which it stands, is also used. By this device even one driving along in the center of the street may readily find the house for which he is searching. Plain but attractive cement lighting posts are also used in California towns, as at San Fernando and Redlands.

Fender for Use on Pleasure Cars

Many citizens have recognized the need for fenders for motor trucks by passing ordinances requiring them to be fitted; few, however, have deemed them necessary on pleasure cars. There is a pleasure car fender on the market, however. It has been installed on their cars by many Philadelphians, in spite of the fact that the device weighs sixty-seven pounds and costs fifty dollars.

The fender is simply a rectangular frame with strong wire strung across it. Normally, it is held up from the ground so that its lower edge is about level with the hubs of the automobile's two front wheels. When there is danger of running into a pedestrian, however, a push on a button drops the fender to within an inch or two of the ground. The button is located on the floorboard of the car, immediately back of the brake pedal, so that as the latter is pushed with the ball of the foot, the button may be pushed with the heel.

This makes the dropping of the fender and the application of the brake simultaneous in time of need, while normally the two are entirely independent.

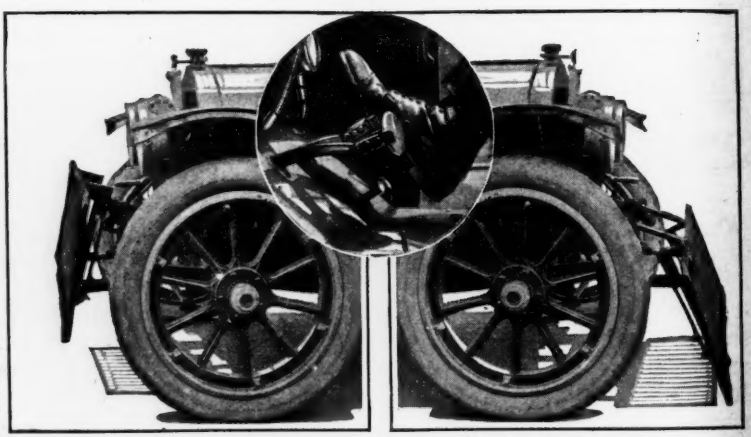
It will be noticed that the fender is not automatic. This is because the manufacturer thinks that "the unfortunate who attempts to assist in his salvation by obligingly knocking down a fender, does not live to tell the tale." As a result the fender has been placed entirely within the control of the driver. Because the fender will be used but seldom, it has not been made capable of being raised from the driver's seat. It has to be lifted back to place by hand, with a pull forward as well as a lift.

The pull forward is necessary to loosen a latch that holds the fender locked when lowered. This is to prevent a body from rolling under the fender, clogging it up, and allowing the front wheels to strike it.

The Government's "Canning Clubs"

In the "Mother-daughter" canning clubs organized by the United States Department of Agriculture, nine hundred and thirty-eight public demonstrations were held during the year, with a total attendance of one hundred and eighteen thousand, three hundred and sixty-seven.

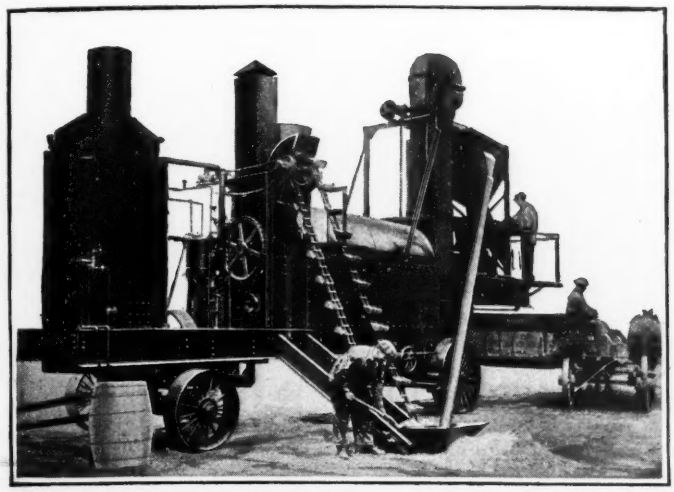
These demonstrations were held primarily for the club members, but parents were always invited, and, as a matter of fact, more than half of those present were grown men and women. One of the great advantages of this club work, indeed, is the fact that it serves to stimulate the parents as well as to the children who make most of the membership.



A push on a button located on the floorboard of the car drops the fender to within an inch or two of the ground

A Portable Asphalt Plant

A new portable asphalt mixing plant has been designed especially to meet the requirements of contractors and municipalities having new construction and maintenance work to perform in scattered territory or in an amount insufficient to make a stationary plant economical. Its availability for bituminous road construction is an important advantage, since it can be hauled from place to place by means of a traction engine or steam roller.



This portable municipal asphalt plant brings pavement repairing within the means of small towns

For a plant of its size and cost it is unusual in having a minimum capacity of eight hundred square yards of two-inch sheet asphalt per day of ten hours. The capacity for asphaltic concrete, topeka mixture or asphalt macadam is much larger.

The mixing platform of the plant is so elevated that a wagon can be driven under it to receive the load from the mixer without elevating the plant on its wheels or excavating for this purpose. The platform is arranged for one-man operation, the levers for controlling clutches and plant being within easy reach. The sand-measuring box and asphalt bucket are supported on scales. A drying drum of special construction has been designed for this plant to obviate the difficulties so often encountered in heating a sufficient amount of sand and stone.

A Waterproof Sensitive Telephone Transmitter

A waterproof telephone transmitter which is sensitive enough to catch the ticking of a watch against the walls of a fish globe, filled with water, has recently been installed in railroad dispatching offices, in mines, on board steamers, and wherever the most trying conditions prevail. With this transmitter, a conversation between New York and Chicago, and the striking of hours and quarters, were heard. Two sets of fifteen dry cells, each connected in series, the sets in multiple, were used; and although the transmitter was submerged in the globe for hours, sound could readily be received and sent through it.

A waterproof transmitter which is sensitive enough to record the tick of a watch through glass

Raising Cucumbers Three Feet Long

One of the most remarkable cucumber stories on record comes from C. F. Hager, a farmer of Glendale, California. He states that during a single season in his hot houses in Glendale he grew cucumbers which reached the unheard of length of thirty-six inches and which weighed over five pounds. These, however, were freak vegetables, the average cucumber being about a foot in length and weighing about a pound. This size was known as "select" and averaged during the "off" season about five dollars per dozen, while the price soared, at different stages, up to six dollars. The "firsts" ranged from ten to twelve inches in length, being from ten ounces to a pound in weight and bringing an average price of about four dollars per dozen, while the "seconds" averaged about eight inches in length and brought about two and a half dollars per dozen.

Raising cucumbers at fifty cents a foot. Sometimes they are three feet long

From his three glass-covered houses, twenty-five by two hundred feet, Mr. Hager has gathered more than twenty thousand dollars worth of cucumbers in two crops.

A Chandelier of Crutches

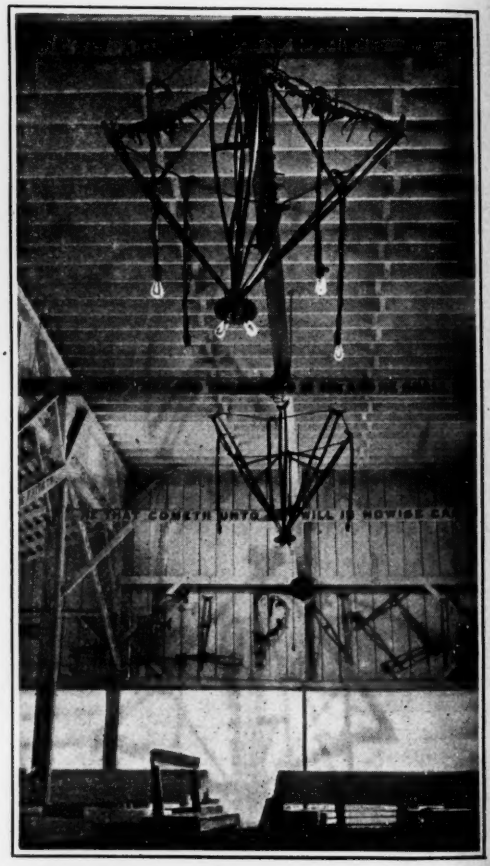
In a "faith-healing" mission in California an odd chandelier was constructed as a permanent testimonial of the belief which the founders preach.

The chandeliers are each composed of five crutches. These are braced by walking canes and the whole is held together by stout wires from which depend a numerous array of tobacco pipes.

The canes and crutches are said to have been discarded by cripples who adopted the faith healing, and the pipes were cheerfully given by those who had renounced tobacco.

Four canes hang from the framework and over these the electric light wires are wound, terminating in bulbs at the end of each.

Where the main crutches in the construction of the chandelier meet in a rough point, it is finished off with two larger lights under a reflector.



Crutches, pipes and canes made these chandeliers

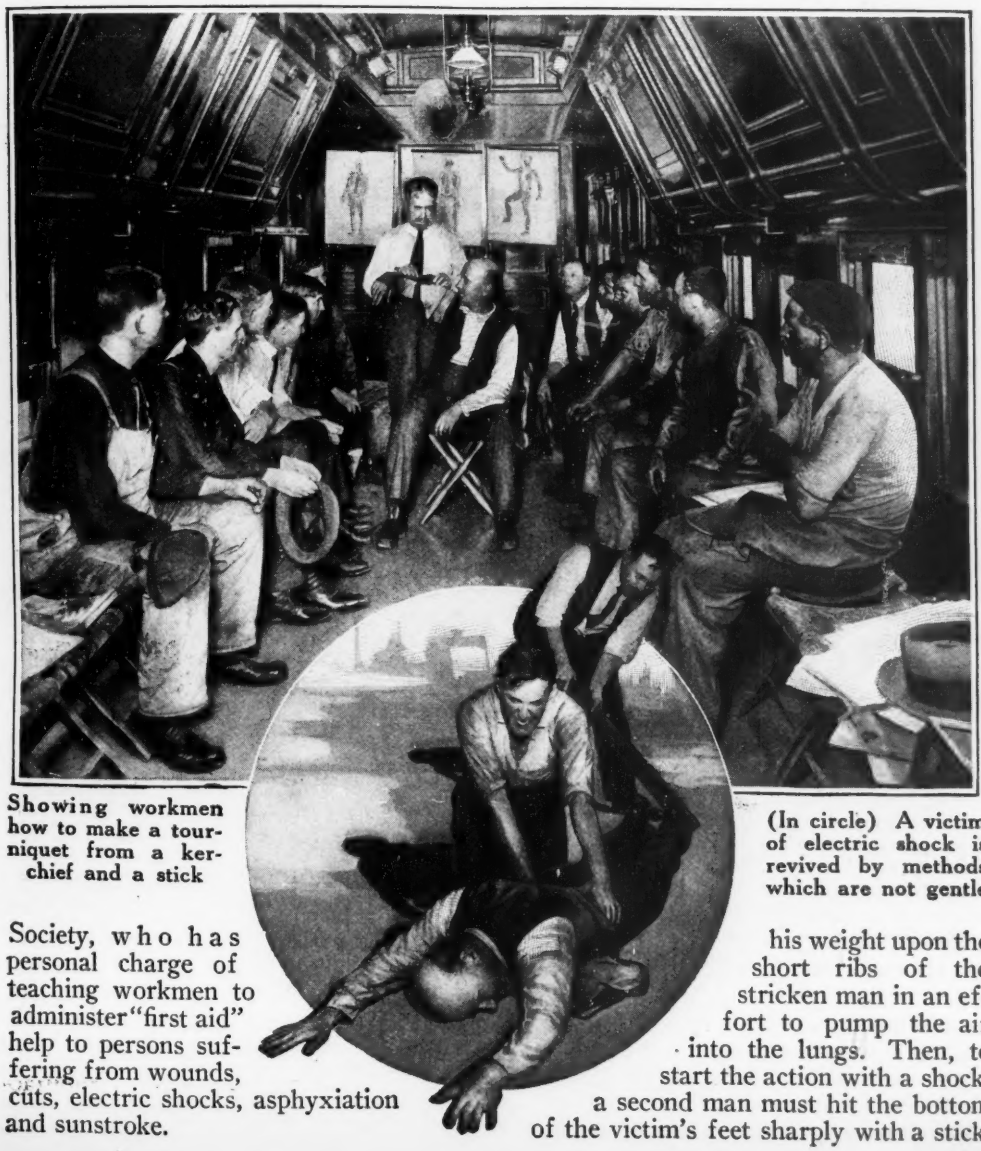
A "First-Aid" Pullman Car

A Red Cross hospital Pullman car is traveling over the country, stopping in freight yards near factories, and teaching railroad workmen and factory employees "first aid" to the injured. It has already traveled more than forty-five thousand miles. So well do employers think of this free hospital training car that they allow workmen to attend the lectures and demonstrations on factory time without deducting from wages.

The Red Cross car is equipped like a modern hospital and is manned by Dr. M. J. Shields, of the National Red Cross Society, who has personal charge of teaching workmen to administer "first aid" help to persons suffering from wounds, cuts, electric shocks, asphyxiation and sunstroke.

Dr. Shields explains to the workmen who gather in the car how a stretcher can be made any time at any place with two coats and two fence posts. The coats are stretched over the fence poles, which are thrust up the sleeves. He also explains how to make a tourniquet, with which to stop hemorrhage from a severed artery, out of a railroad flag or an old handkerchief, with a lump of coal, a stone or an old bolt.

He shows how to revive a victim of electric shock. He is placed on his stomach on the floor with head turned sideways. One man must then press with all his weight upon the short ribs of the stricken man in an effort to pump the air into the lungs. Then, to start the action with a shock, a second man must hit the bottom of the victim's feet sharply with a stick.

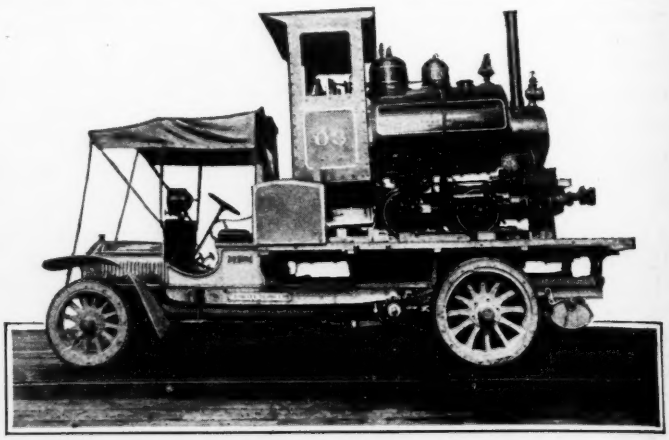


Showing workmen how to make a tourniquet from a kerchief and a stick

(In circle) A victim of electric shock is revived by methods which are not gentle

Delivering Locomotives on Motor Trucks

With a saving in hauling expenses of one-third, the fleet of motor trucks in use by the Baldwin Locomotive Works of Philadelphia demonstrates the efficiency of such machines in unusual transportation service. The trucks are required to carry bodily small locomotives to the railroad shipping points or to the docks for export—a method which was found less expensive to install than a special system of trucks to run the locomotives on. When the trucks were first put into service by this great factory, four of them displaced a dozen wagons and twice as many horses, and the saving was so marked that the fleet of motors has been increased to twelve.

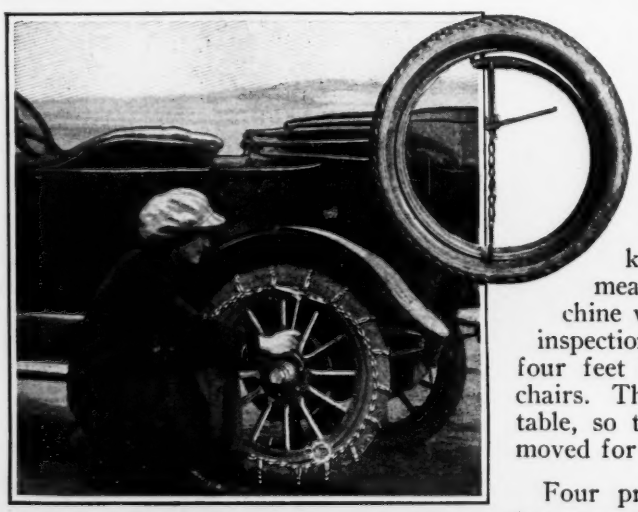


Small shop locomotives are easily carried on a motor truck

Tool Simplifies Putting on Tire Chains

A tool has recently been brought out which greatly simplifies the putting on of tire chains. The device consists of a dog and ratchet, the dog holding the ratchet in any desired position. The ratchet is fitted with hooks which grip the chain ends, and by operating the handle of the ratchet back and forth the ends of the chain are pulled together. The ratchet locks itself in position and holds the chain ready for closing the clamps.

The operation of the tool is very simple. It is placed between the casing and the chain, and one of the hooks is fastened to the last link on the cross chain, while the other is fastened to a link in the main chain. The handle is then operated back and forth, which slides the pawls on the ratchet. To release the tool, the handle is pulled upward and the hook fastened on the cross chain will slip off. The device is excellent in that it allows the chains to be put on tightly, so that they do not become broken or lost. It may also be used as a rim tool in much the manner used with the chains.



A device which makes it easy to apply non-skid chains

Interesting Railway Engineers by Means of Motion Pictures

The Pennsylvania Railroad is instructing its signal fitters and testing its locomotive engineers as to their knowledge of the signals by means of a motion picture machine which has been installed in an inspection car. The car, which is forty-four feet long, is provided with forty chairs. The screen and machine are portable, so that they may be quickly removed for use in a hall or room

Four prominent aeroplane manufacturers are shipping to Europe an average of fifteen aeroplanes a day.

Suns and Worlds in the Making

By Frederic Campbell, Sc.D.

Late President, Department of Astronomy, Brooklyn Institute of Arts and Sciences

THE theory of Laplace is still generally accepted, that our solar system originally evolved from gas. Could we witness the process whereby this transformation was accomplished, how awe-inspiring it would be found! But our eyes are ever too close to the pages of the book; we are too near-sighted as well as too short-lived. Place us in some distant spot of the universe, where the light record of the creation of suns and planets has just arrived, and we could peruse it all, as we can a much belated letter. But, with reference to thousands of similar systems, that is just where we are. The story is just now coming in. We look today on the things of a century, a millennium, ago. Light traveling at the rate of one hundred and eighty-six thousand, three hundred miles a second, requires more than four years to come from the nearest star, perhaps thousands and tens of thousands of years from the farthest. Hence in every case we see not what is, but what was.

Now, as we thus gaze into the depths of space, if we discover traces of any processes going on, we become actual witnesses of the processes. And if anywhere through space we behold great masses of glowing gas being transformed into solar systems like our own, then we have ocular evidence which even Laplace did not possess, that the solar system likewise emerged from a cloud of gas.

While thousands of nebulae have been discovered in the heavens, only two are visible to the naked eye, namely, the great nebula in Orion, and the great nebula in Andromeda. The former, estimated at two thousand times the diameter of the solar system, seems to be a great though beautiful mass of confusion. The latter, estimated at six hundred times the diameter of the solar system, appears elliptical as to figure, and confronts us with problems comparable with those of Saturn's rings when first discovered.

The condition of nebulae is not revealed until photography co-operates with the telescope, and, by means of exposures covering hours, obtains record of details of structure that would otherwise never be known. The spiral pattern of some few nebulae has long been confirmatory of Laplace's nebular theory. But there has recently come in much evidence of the spiral character of other nebulae.

Photograph by Yerkes Observatory.

There are many such spiral nebulæ in the heavens. This is the one known as Canes Venatici. It looks like a pinwheel. In a sense it is, for it is revolving at a dizzy speed—a speed a thousand times that of the earth. Here we see a world in the making

THE BIRTH OF A SOLAR SYSTEM

Photograph by Yerkes Observatory.

The great nebula of Andromeda is often taken for a star of the first magnitude, yet the telescope discloses it as a cloud of luminous gas, whirling on its axis in a plane at an angle to our sight, a mass of star matter in the process of becoming a whole solar system. When the process is completed, aeons hence, the system will be far vaster than our own. Although its speed is terrific, yet in the history of astronomy not the slightest change has been noted

The conclusion seems forced upon us that practically all are in a state of rotation, and are hence supplying the centrifugal force to throw off the rings which, Laplace taught, roll themselves up into planets revolving about central suns.

The very confusion of the mass in the great nebula in Orion suggests that some kind of motion has here been at work. Portions of the nebula may be lacking in illumination which might otherwise show it to be spiral, rotating in space. The fact that the spectroscope has recently demonstrated motion in this famous nebula confirms the suspicion that it is doing what we know that so many others are.

The spiral nebulae, of which so many are now found, may be divided into two classes, those that are seen edgewise and those that are seen flat. Those seen edgewise sometimes present little more than a central sun, not yet fully condensed, cleft laterally into halves, showing that something stands between their central portions and ourselves. This something is evidently a thin disc of matter surrounding a central sun, but whose extension far into space we are unable to see. In other cases, however, the thin disc is plainly visible, and it becomes more apparent, if the nebulae be viewed somewhat tipped, as it is considerably in the great nebula in Andromeda, the reason for its elliptical appearance being obvious.

That these gases take the flattened disc form instead of the globular is convincing evidence that they are rotating, the centrifugal force thus generated flinging their elements far outward.

But, when opportunity is given to look directly down upon a nebula, there results startling evidence of its being in rotation. There is no other way of explaining its remarkable details of structure. Some look like the propeller blades of a motor boat; some appear like spinning wheels; and some are actually caught in the act of throwing off rings, which are seen condensing at certain centers, rolling themselves into planets, henceforth to travel around their suns. The great nebula in Andromeda gives striking evidence that it is working out another and a greater solar system than our own.

Photograph by Yerkes Observatory.

The Great Nebula in Orion is a mass of glowing gas which forms the middle star of the "sword" of Orion. Through its luminous body gleam stars far beyond it. Its confused mass is now generally believed to indicate that it, too, is in rapid motion

In short, it seems that, in studying the nebulae, we are being admitted to the very workshop of the universe, and are permitted to watch the actual process of turning out worlds. Nothing in the heavens is better fitted to fill the very soul with awe. As in the case of the "fixed stars," our lives are too brief, too feeble our eyes, to detect the actual motion. But science determines the unmistakable facts, and reasoning does the rest

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A Natural Substitute for Eggs

A Southern cook has patented a substitute for pudding and cake eggs. Yams are boiled until they are completely cooked, after which they are peeled and cut into thin slices, baked in a slow oven until they are crisp, and then powdered. Two drops of rose extract are added to each teaspoonful of the powder. One tablespoonful of this composition is claimed to be equal to one egg in the making of pastry, cakes, muffins, etc.

Reading Gas Meters with the Camera

A special kodak has been perfected for the use of men on meter-reading routes, the object being to enable them to bring into the office at the close of the day's work photographic evidence of the position of the dial pointers on the meters of the customers visited.

In order to take the reading of the gas or electric meter the man sent around by the company simply holds the camera opening against the meter dial glass and presses a lever, which automatically opens the shutter for a definite period and at the same time lights four small battery-operated lamps to illuminate the meter dial. After each exposure is made, the shutter is locked and cannot be operated again until the film roll has been turned to the position for the next picture.

The device can also be used as a hand lantern in dark passage ways by pressing the lever a part of the way down without operating the shutter.

The camera photographs the meter and thus obviates disputes

Each roll of the special film used provides for seventy-five exposures. Two additional rolls can be carried inside the camera box.

Exhibition Visitors Design Homes

The Institute of Architects of Sydney, Australia, has arranged a novel competition in connection with the "Ideal Home Exhibition," which is shortly to be held in Sydney, and of which twenty-five per cent of the receipts will be given to the Red Cross Society. One of the objects of the exhibition is to stimulate interest in the making of an ideal home.

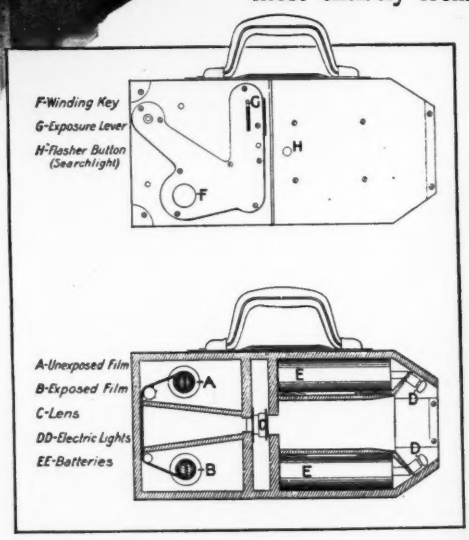
In the competition every visitor will be asked to compete in the building, decorating, furnishing and equipping of an ideal home from material exhibited.

Raising $5,000 Silver Foxes for Market

To raise silver foxes calls for a pair of foxes, which will cost from $150 to $250 each for the common foxes, and up to several thousand dollars each for the best.

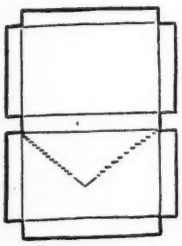
The prices of furs and of breeding silver boxes have fallen considerably since July, 1914. The prices, running into thousands of dollars for live silver foxes, were based, not upon the fur value of the animals, but on their possibilities as breeding animals, in an industry in which there was great speculative excitement.

The business of fox breeding will be on a much more stable basis than at present when the value of breeding animals bears an approximate relation to the value of their pelts in the open market. The profits in silver fox farming prior to 1910 were realized mainly from the sale of pelts; since then they have been derived almost entirely from the sale of live foxes for breeding purposes. There has been a sharp decline in the prices of breeding stock.



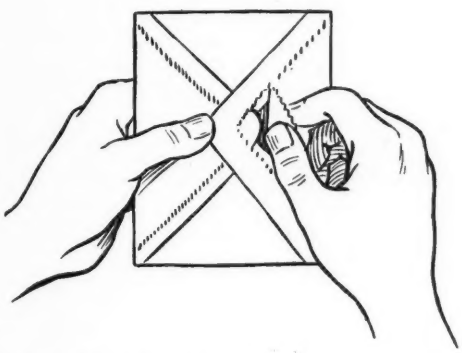
The device is so constructed as to furnish light for its own photographing. It is capable of many uses besides meter reading

A Time-Saving Envelope



The perforated flap

To business men and others who have to open a great number of letters and who find the old-fashioned flap envelope a time-consuming nuisance, the idea contained in a recent invention would be an effective time-saver. To enable the recipient of the letter to open it with a single stroke, a set of parallel slits with over-lapping ends is provided in the flaps of the envelope. A small tongue is cut in the paper at the point where the lines meet. When this tongue is pulled, the paper



Perforations along the flap make this envelope easy to open

tears diagonally from one slit to another in rapid succession. Thus, with a swift movement, the envelope is neatly and squarely cut open without injuring the contents.

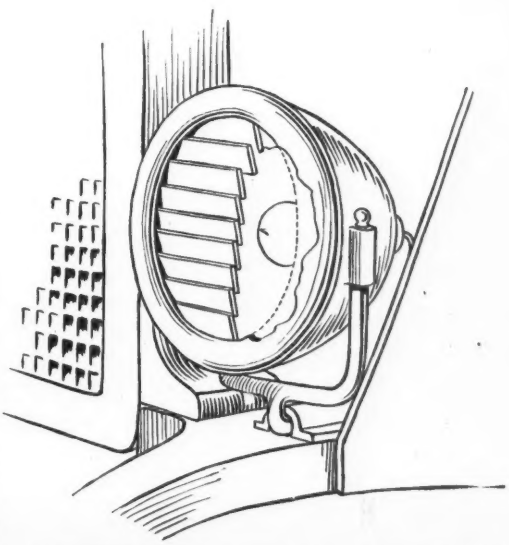
A Hydrogen-Oxygen Motor That Will Not Work

According to the newspapers, George Harris Moriarty is the lucky inventor of a new motor for automobiles, in which he explodes hydrogen-oxygen, *after compressing the mixture,* obtaining 89% of the theoretical power released. To put it mildly, somebody made a mistake. Hydrogen-oxygen, when ignited, *contracts,* a quart of the gas mixture condensing into a few drops of water; there is no expansion of any kind and the only power which it would be possible to obtain would be the pressure of the atmosphere upon the outside of the cylinder pistons, endeavoring to push the pistons into the vacuum caused by the condensation of the gas mixture. The greatest power obtained would be by making the mixture as *thin* as possible, not to compress it, and even then it would only amount to 14.5 lbs. per square inch, the pressure of the atmosphere.

Device for Dimming Auto Headlights

Headlight dimming is now compulsory in so many states that any motorist who tours must have some device which will secure the desired dimming effect. Several of these devices have already been described in this magazine. Nearly all utilize in some way or other the idea of catching rays projected horizontally forward and upward and turning them slightly downward to the road surface.

The new reflector shown in the accompanying illustration consists of a series of prisms placed in such a manner as to throw a strong non-glaring light five hundred feet ahead. Prisms, arranged clapboard fashion, run across the front lens. The lower end of each prism overlaps the next lower one. The prisms are arranged at such an angle as to cause the proper deflection of the direct rays.



A headlight dimmer consisting of a series of prisms arranged clapboard fashion

Making Motion Picture Cartoons with Ammonia Fountain Pens

By Horace A. Fuld

About a year ago Charles A. Birch-Field, the illustrator, was asked by one of the film companies to draw some cartoons to be reproduced in their films. He agreed, and proceeded to take what he imagined to be short-cut to easy money. The task was the drawing of several cartoons (not the animated ones) that you see now in almost every pictorial news-weekly. The subjects were to be the latest styles, treated satirically, as well as events that come under the head of caustic pen comment.

At the time that Mr. Birch-Field was asked to do this work, the method of procedure was about as follows: A drawing board was arranged under a battery of high-powered illuminating lamps, with the camera rigged up directly overhead, the lens pointing downward and focussed on the drawing board. About sixteen pictures per second were thus made, more than ten images per second appearing as a continuous image to the eye. As the average cartoons for the weekly news picture may occupy one hundred feet of film, and as, further, a fraction more than a foot per second travels through the projecting machine that throws the image on the screen, one thousand seven hundred different photographs must be taken. This is done automatically, in most studios, simply by pressing a button each time a picture is taken.

Mr. Birch-Field set about finding some way that would make the work less arduous. As a result he has devised a very promising process. Mr. Birch-Field first has an enlarged photograph made of the cartoon or drawing to be reproduced, the size of the enlargement being fourteen by eighteen inches. This enlargement is dipped in a bath of bichloride of mercury, washed in water, placed in a solution of hydrofluoric acid, rinsed again, and lastly, treated in a bath of bichromate of potassium, dipped in water, dried, and placed flat upon the drawing board. As in the old method, the camera faces the drawing board, lens down, the drawing having completely disappeared from the enlargement. Lamps are ranged on either side of the board for the required illumination, and all is ready for the actual photographing of the cartoon.

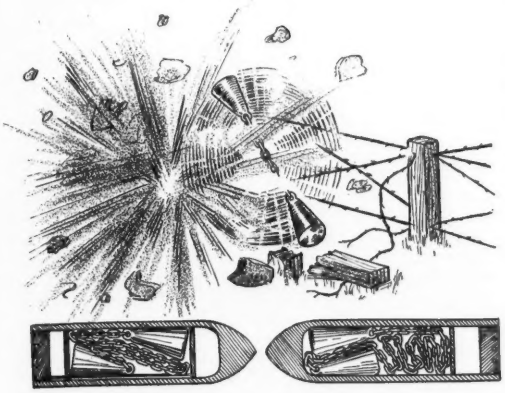
With a fountain pen filled with ammonia the original lines of the enlargement are retraced in the manner illustrated, exactly as they appeared prior to their chemical erasure. They reappear as by magic. The original drawing (or a duplicate enlargement) is used to guide the hand along the original lines. A slip does not matter; no mark results where there is no line beneath.

The cartoon is photographed by a continuous revolution of the camera crank and a gradual and seemingly natural line drawing, at whatsoever point the pen is applied, results. It takes just four minutes after the prepared enlargement is on the drawing board, supposing that we are dealing with a subject one hundred feet in length, to make a film negative ready for the developer and printer.

The three small cuts show the steps in producing the finished effect of a rapidly drawn animated cartoon. At the left is the original drawing; the middle cut is the drawing washed out by chemical baths; at the right the ammonia-filled fountain pen is bringing the cartoon back to life

Chain-Shot in a New Form

A shell containing two weights and a chain, instead of the usual shrapnel balls, has been devised by a Connecticut inventor. The object of this new form of explosive projectile is to tear down wire entanglements and other obstructions in its path. This chain projectile is provided with a bursting charge of

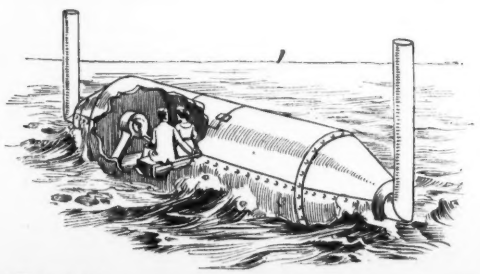


When the shell explodes two weights connected by a chain are thrown out and tear down the barbed wire entanglement

powder and a time fuse, as in ordinary shrapnel. The chain is free of the shell, so that when the latter explodes in front of an obstruction there is nothing to impede the chain and its weights. It is evident that the inventor was inspired by the chain-shot used in the days of frigates to carry away rigging.

A Lifeboat Which Cannot Capsize

The accompanying illustration shows a life-boat which, on account of its peculiar construction, may be considered practically unsinkable. Its body is made of an external shell with tapering ends through which extend two L-shaped



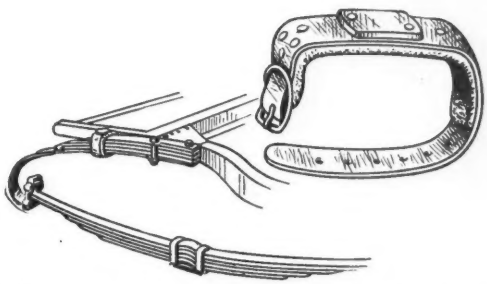
This lifeboat always remains right side up

tubes for supplying the occupants with air. But this is not the only function of these tubes. They revolve freely on their watertight bearings in the tapering ends; and from the inner extremities of the tubes there is suspended a wooden floor with seats mounted on its upper surface. Tanks containing water and food are secured to the bottom of the floor. Thus the floor is actually independent of the shell, and no matter how severely the life-boat may pitch in a heavy sea, the claim is made that the floor within will always rotate with the L-shaped tubes and maintain its level.

Strap Pad Oiler for Auto Springs

Few automobiles of the cheaper type have a provision for oiling the springs. Oiling the spring leaves seems to be the thing a motorist usually forgets, and many a touring party has been compelled to turn in at the first garage to have the spring leaves pried apart and graphite or other lubricants forced between them.

As a sort of insurance against lack of lubricants an extremely simple and cheap device has been invented. The leather



An oil pad strapped on springs after this fashion provides oil in one of the parts most commonly overlooked

strap passes around the leaf spring, and is held in place by an ordinary buckle. The strap is lined with a pad of wicking, which is saturated with oil to feed the lubricant in small quantities to the spring leaves, then the swaying of the car forces them apart. A hole in the strap, protected by a cover, admits the spout of an oil can. The leather is chemically treated so as to prevent absorption of oil. Two straps are required for each semi-elliptic and four for a full elliptic spring.

"Improving" Nature's Christmas Trees

By William K. Marshall

ACCORDING to the records in the division of ornamentation of the United States Patent Office, there are a round dozen "improvements" in Christmas trees. They are classed under "artificial trees." "Improvements," according to the examiners who have charge of these patents, is used advisedly. For your modern artificial tree is fire proof, collapsible for transportation, admissible of gas or electric lighting, and "as good as, and as sightly as the natural tree." One of these inventors has even applied a more practical possibility still. "My tree," he writes in his patent specification, "can be dismantled of Christmas decoration, pegs inserted where the artificial branches were and be used as hat or clothes rack during the rest of the year, then re-decorated when Christmas returns."

The industry of artificial Christmas tree development, though of comparative recent date, is a direct outgrowth of an enormous industry in artificial fruits and flowers.

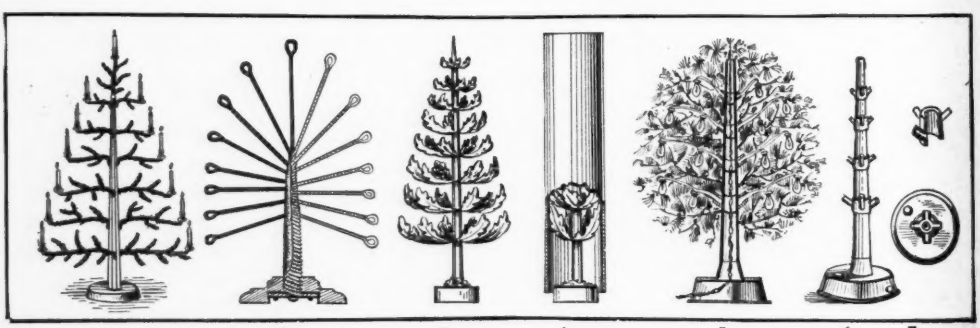
F. C. Bowen, the pioneer inventor of artificial trees, designed his to be adorned for feast and gala days, for advertising display or for such other use as consumers cared to put it to. Though he makes no mention of Christmas trees in his application for a patent, his specifications form the nucleus for later ideas which improve his improvement on nature.

Mr. Bowen's artificial tree becomes an imitation of the natural tree by providing a stem supported by a base. His stem and branches may be covered with any material which imparts a likeness to natural bark. His branches are attached to slight projections from the "trunk" by coils of wire.

When August Wengenroth, of Troy, New York, submitted specifictions for an artificial tree his design was to offer an announced substitute for a Christmas tree. "My invention," he wrote, "furnishes a portable imitation Christmas tree ready for use. It can be made fire proof if covered with alum or other substitute, and it admits being used from year to year if properly stored and packed."

Mr. Wengenroth's innovation which, in the main, supplies the basis for later improvements, consists of an upright trunk to which are applied a number of detachable branches of wire covered with chenille—a soft tufted or fluffy cord of silk, wool or worsted. The ends of the branches have spirally bent terminals which hold drip cups in which candles can be fixed. Ground cork or similar material can be used to apply to the trunk and branches to give the tree the color of the natural tree.

To improve the artificial tree further



1 2 3 4 5 6 7

1, The Wengenroth tree, whose detachable branches have drip cups for candles. 2, The bare frame of Miss Crook's tree, which is made of twisted wire. 3 and 4, A tree invented by W. T. Strasser, with flat leaves which slip into the tube for storage between seasons. 5, The Hummel tree, which approximates nature better than any of the others. 6 and 7, Sectional views showing the means of applying the branches to the Hummel tree

HOW INVENTORS HAVE TRIED TO IMPROVE ON NATURE'S CHRISTMAS TREES

and make it a nearer resemblance to the natural fir tree, he suggested the idea of driving "eyes" into the trunk, which aimed toward a better imitation of the natural aspect of the bark. This imitation was so perfectly carried out that the inventor arrived at a realistic imitation of the growth of branches in their gradual diminishing from the lower to the upper trunk. The leaves appear in his specifications as elaborate imitations in muslin, paper or "other flexible material." They are attached to the stem of the tree by dipping them in mucilage or other adhesive, and while the leaves are still wet, they are sprinkled with scales of mica or similar mineral. This gives the representation of snow, which the inventor thinks is "a beautiful effect."

Annas Hummel spent more effort in arriving at an imitation of the Christmas tree than did any of his predecessors or followers. His idea for a trunk is a very stout stem built in sections so that it is readily collapsible for shipping or storing. The branches are attached to the main stem by wedging devices. In other features he holds to the imitation of the natural tree by corking the trunk and imparting the natural tapering effect to trunk and branches.

It was Mr. Hummel who claimed for his invention the extension of its practical possibilities in easily converting it into a hat or clothes rack when its Christmas mission was done.

Three women are included in the list of inventors of Christmas trees. They are Mary C. Crook, of Nebraska; Eva C. Leonard, of Pennsylvania, and Mary D. Berry, of Connecticut. Miss Crook claims that her conception of a Christmas tree is to provide one that is "strong, inexpensive, fireproof, attractive and adaptable for collapsibility and easy transportation." Its sub-structure is of wires which are twisted to hold branches and trunk together. This is covered by a superstructure of material simulating the naturalness of the tree.

Miss Berry advances on the conceptions of her predecessors and claims that in her tree "it is almost impossible to tell it from a real tree when it is dressed." It combines all the improved features and employs needle-like attachments to the branches which admit of secure and easy decoration with candles and ornaments.

An original idea for a Christmas tree was given out by Miss Leonard. Her tree has a stiff, symmetrical framework. Its upper structure is composed of superposed tiers or rows of branches gradually diminishing as they ascend. Metallic bars which enclose this creation bear a cup for a candle at each of its corners. This is alike fireproof, portable, and available when the forest fir is not.

Unspillable Medicine Bottle and Eye Glass

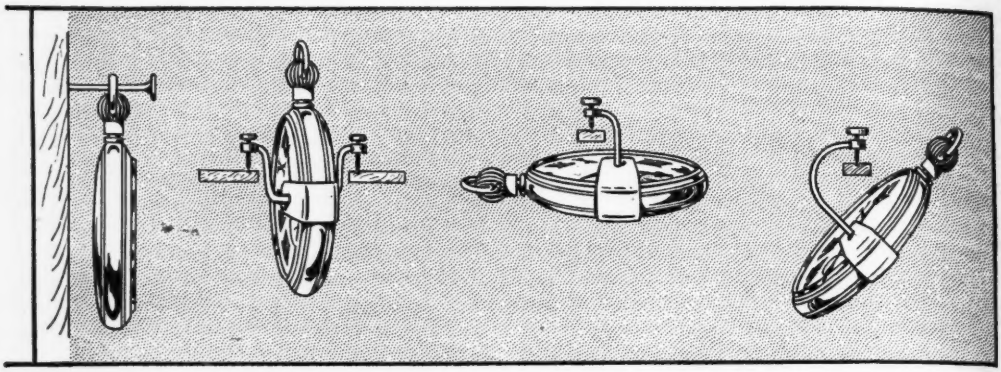
A new automatic bottle, which allows even a small child to take his medicine without aid, has recently been placed on the market. There is no possibility of spilling the liquid and no spoon is necessary. Hence it can be conveniently carried in the pocket. A wide-mouthed glass bottle with a screw cap filled with a rubber plug is the bottle proper. Through the rubber plug a glass tube passes, which ends in a funnel-shaped cup, on which different sized doses are indicated by lines and figures as in a graduated measure.

These bottles cannot spill, and measure perfectly

To take a dose of medicine, the cap is unscrewed and then screwed down, the latter operation compressing the air inside and forcing the liquid to rise to any desired height in the tube. Another device of like order is the eye-cup, which utilizes the same principle embodied in the medicine bottle

The Fickleness of Watches Explained

By Leonard Keene Hirshberg A.B., M.A., M.D.



Tests with watches show that their environment affects their timekeeping qualities almost as much as human beings are affected by their surroundings. Suspension in various positions results in various rates of pendulum-like vibration, which have an invariable effect on the timekeeping, which can even be rated for distinct localities

WATCHES and clocks are such commonplace, every-day articles of necessity that many persons think there is nothing new to be learned about them and the time they keep. Think but a moment, what time itself is. Time is not a thing that is kept by watches and clocks, much less correctly. A watch in the house measures, not keeps, altogether different time from the same thing out-of-doors. Moreover, a watch in the sunshine is an entirely different watch in the rain. In the summer-time heat expands the springs, balance wheels, steel, gold and other parts of the clock or watch, so that the effect is noticeable. Friction and size have much to do with this, also. In cold weather, the metal and other elements in a timepiece contract and shrink to such an appreciable extent that friction and interference of one wheel with another are reduced to a minimum and the watch becomes fast. How, then, is anyone to know precisely what time it is at any moment? What is a moment?

The impossibility of ever knowing the absolutely correct time at any place as well as other important facts of timepieces has just been made by the distinguished English Professor Turner, of London. It was all brought about by a curious experience he had with his watch on the Isle of Wight.

Owing to the breaking down of a wireless apparatus and the difficulty of getting the official Greenwich time, which is regularly obtained by astronomical observations of the sun, moon and stars, Professor Turner attempted to correct the Isle of Wight time by a watch, which he wore, with a scientifically determined summer slowness of seventh-tenths of a second a day—a fairly accurate timepiece, one must admit. This watch had been set at Greenwich, a much warmer place than the Isle of Wight, yet the professor was startled to find suddenly that his chronometer began to gain fifteen seconds a day.

Hitherto, it had been his custom to keep the watch in a fixed upright position during the night, but on the Island he had suspended it from a bedpost by its chain. On the third morning, it was seen to be swinging like a pendulum, under the influence of its own balance-wheel.

I have had this same experience with one of my watches, which is always suspended by a loose wire ring from a cross bar of my desk-lamp. One of my assistants has frequently called my attention to the same fact, but neither of us thought it was due to its own balance-wheel, but rather to outside rumbling of carts and cars.

When Professor Turner returned to his observatory, the watch was checked

up by the astronomical clocks for one hour and found to be keeping perfect time. It was then suspended from a nail, so that it would vibrate. Its rate was found suddenly to increase and become two and three-tenths seconds fast per hour! When it was in his vest or watch pocket it was correct, when suspended it was two to three seconds fast per hour. Another watch, similarly tested, was correct in his pocket and from six to seven seconds fast every hour, so that in a day it went two or three minutes fast. Each watch was different from the other. These new discoveries show how important it is to consider what you do with your watch when you change your clothes—especially during the night.

Several experiments have been made to discover the conditions which cause this increase in a watch's rate. Many and various kinds of watches were tested and every one without exception was found to be similarly affected. It was found that the oscillations were invariably intermittent. One watch—the one first mentioned—made eight beats and then stopped. Evidently the number eight was due to the relation of the period of the watch, acting as a pendulum, to the period of the balance-wheel.

A light, metal clip, as in the pictures, was made to hold the watch, fitted with two adjustable pivots. Thus the extent of the swing—the "period"—could be readily varied. A mirror was also arranged so that the beam of its reflected light could be used to measure the extent of the oscillations. The balance-wheel made one hundred and fifty oscillations a minute. Tests were conducted with the watch swinging at various frequencies from one hundred and twenty to one hundred and forty-seven. The rate in seconds per hour was found to be about five and four-tenths times the extent of the degree of oscillation. This five and four-tenths depends on the power of the mainspring and in the weight of the watch and varies in different watches.

Watches gain consistently and the nearer the frequency of the watch's swing approaches that of the balance-wheel, the greater is the gain. Moreover, with the watch oscillating in a vertical plane, the nearer the center is brought to the axis of rotation, the more the watch becomes a flywheel itself, rotating on its own axis.

With the watch hung flat and face upwards as shown, there is not much effect on the time of the watch. At most other angles, the number of seconds of increase varies and the wheel also up to one hundred and eighty vibrations per minute.

A locomotive engineer on a railroad innocently wrote to a scientific periodical that his watch had been carried thousands of miles. His letter was seen by Professor Turner. The engineer wrote that he had found that while the vibration to which his watch is subject makes little difference, if used on similar engines at similar speeds, yet a different class of locomotives with varying velocity makes his watch fast.

A watch that gained only two minutes a day on the ground, on a thirty-mile an hour locomotive with a five foot six inch driver kept correct time. On a locomotive with a seven foot three inch driver, making forty to seventy miles on hour, the watch would gain from sixty to ninety seconds a day. No wonder that locomotive engineers find that their watches are rarely correct at the end of a run.

Perhaps the same can be said of clocks in automobiles, ships and aeroplanes. Motoring, riding and walking all cause errors in watches. A man who motors, takes a ferry, then a train, and finally walks will find that his Sunday-go-to-meeting time on the same watch is much slower than week days. Jewelers also have blithe excuses (animal magnetism and similar superstitions) to explain why the same watch on Jim Smith changes its time on Bill Green. The true explanation now appears for the first time.

Playing Geometry With Corks

An interesting geometrical experiment can be performed with a pan of water in which several corks pierced with needles are floating and under which a permanent bar magnet is placed. A single cork will float to a position directly over the magnet; two corks will float to points on either side of the bar, three corks will form a triangle, four a rectangle, eight an octagon, etc.

Removing Snow by Dissolving It

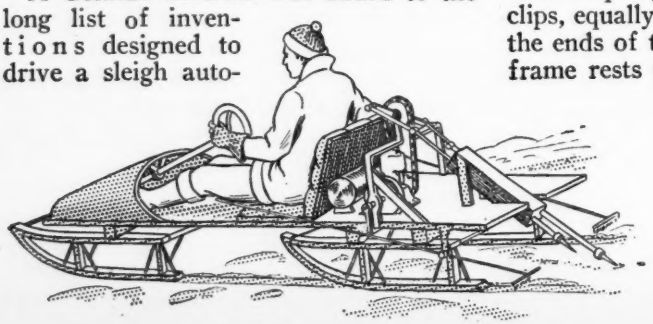
The time and expense involved in snow removel in large cities are largely controlled by the distance to the dumping ground. This factor is so important that it is often a prohibitive one. To

Dumping snow into sewers and dissolving it with water has saved New York hundreds of thousands of dollars a year

overcome this difficulty, and to supply dumping grounds at convenient intervals in the city is the object of the invention shown in the sketch. By means of two slanting chutes extending from the street surface into the drain pipe the snow is dumped into the latter. Here a rapidly revolving jet of water, supplied from the hydrants of the city's fire supply, causes the snow to melt and leads the water away through the city sewer system. More than one stream can be used to melt the snow at the bottom of the chutes; and likewise, as many of these melting stations can be established as may be required by the size of the city.

A Motor Sleigh

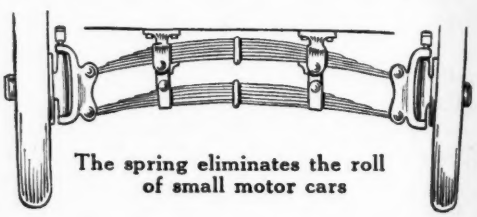
A German inventor has added to the long list of inventions designed to drive a sleigh automatically, the device illustrated in the sketch. Its motive power is supplied by a gasoline engine mounted behind the driver's seat. By means of a chain the power is transmitted to a horizontal crank-shaft which operates the two plunger-rods. These are placed one above the other and are made to move through two guiding grooves. By means of the sharp points these plungers are made to engage the snow, ice or other road surface, and so to propel the sleigh onward. A brake is also provided with a point to be dug into the snow.



A motor sleigh which will run on ice and snow

New Front Spring for Small Cars

At a time when many mechanically-inclined Americans construct their own automobiles from spare parts and discarded old cars, the type of front spring shown in the accompanying illustration should be of particular interest. Springing the front axle of a light car has always been a difficult matter, particularly if the spring is to be a transverse one,



The spring eliminates the roll of small motor cars

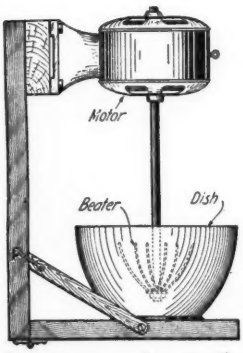
pivoted in the center, since in such a case the car shows a tendency to roll on uneven roads. To overcome this well-known tendency a British engineer has designed a type of front spring which combines the good points of the cantilever with the lightness and strength of the front transverse type. The two sections of the spring are joined by two spring clips, equally distant from the center and the ends of the springs. The end of the frame rests upon these clips, so that no front axle is required. As each spring, because of the position of the clips, acts as a cantilever suspension, the car rides easily, while the wheels rise and fall in parallel lines. There is no appreciable roll, even on rough roads at high speed.

The Home Craftsman

An Electrical Egg-Beater

An electrical egg-beater, so simple to make that it can be readily understood from the sketch, is presented herewith.

Secure a base, 6½" long and hinge it onto an 18" upright board, as shown. Fasten a block, about 2" thick, at the top, and to this fasten a small electric motor. A brass stem is fastened to the shaft, and at the end of it are soldered some brass strips, to make the "beater."



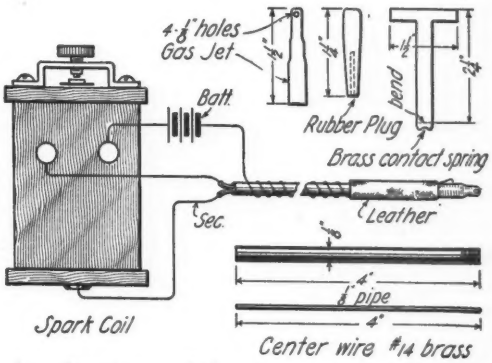
Beating eggs electrically

The base has a hinge so that it can be lowered at will to hold the glass, containing the eggs. The motor, however, may be fixed to slide up and down which, of course, eliminates the necessity of hinging the base.

Electric Lighter for Gas Stove

An old automobile spark coil of the vibrator type and two or three dry cells are the principal parts needed for this device. If the coil has three leads connect up as shown and if it has four leads hook one end of secondary on to primary to save extra wiring. Use straight, heavy, portable cord to carry the current to the lighter. Around the outside of this cord is wrapped a single cable which connects the battery with contact spring.

Details of the lighter are also given. Bend the tip of the gas jet slightly towards the center and drill four holes about ⅛" from the end. In connecting secondary to center wire, solder and cover connection with rubber tubing or tape before placing point wire in rubber plug. Solder one battery wire to ⅛" pipe, assemble parts and heavily tape handle, then bend the base of the contact spring around it, placing this so that the end of contact will touch the brass tip when pressed. To prevent shocks it is a good idea to tape the whole handle after completion. If the point is exactly in middle of tip the sparks will spread out in all directions when the circuit is closed.



An electric gas lighter made from left-over materials

Indelible Ink for Marking Clothing

Nitrate of silver 5 scruples; gum arabic 2 drachms; sap green 1 scruple; distilled water 1 ounce. Mix together. Before writing on the article to be marked apply some of the following: Carbonate of soda ½ oz. and distilled water 4 oz. Let this last, which is the mordant, get dry, then with a quill pen write what you require.

An Effective China or Curio Closet

A simple but very convenient china or curio closet to be nailed to the wall can be made for less than $5, using best grade chestnut for the woodwork. This includes the leaded glass, or, if one prefers, small diamond panes of ordinary window glass, with the lower half of the doors of plain glass.

The back of the closet is made of finished boards nailed to end cross-pieces, grooved and tongued ready to fit. The top board can be cut with a scroll saw or a key-hole saw after any simple pattern desired. It rests on the top of the closet, and is held in place by the side uprights.

The side uprights are made of 2″ x 2″ sticks, cut square and polished. The ends can be finished plain or topped off with some simple metal ornament. The side, top and bottom boards of the closet are plain finished lumber, and the ornaments of wood nailed on the outside when knocked together. With the lumber cut in the dimensions specified the assembling of parts is little more difficult than the nailing together of a box. Tongued and grooved, the corners are more finished, but they can be nailed and glued together with almost as good an effect. Small-headed wire nails should be used, driven ¼″ in the wood, and the heads puttied up.

This closet can be made for less than five dollars, including leaded glass doors

The doors are the most difficult and costly of the structure. They are not, however, beyond the skill of any one at all handy with tools. As the glass must be fitted on the inside, a groove for it must be gouged out with a chisel. If leaded glass is used for the upper part, it can be ordered of the right size, and then fitted in with cross bars at 6″ intervals. If small diamond window panes are used it will pay to have the frame made at a mill. Such a sash, with the glass in, and painted one coat, costs about $1 a door.

Brass hinges, and a small button or knob, complete the closet. Finished off in hard oil to a dull polish the closet is an ornament to any den or dining room. It is intended to be screwed to the wall, but it may be hung if the lower ends are fastened to a substantial base, such as the top of the wainscoating.

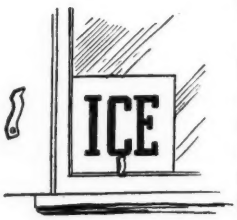
Clearing Ready-Mixed Paint

Amateurs doing jobs of painting around the house generally use prepared paint, which is often troublesome, unless the dealer keeps fresh stock on his shelves. The solid matter cakes in the bottom of the can, and it is very difficult to stir it up.

When this occurs, pour the paint into a larger pail, taking care to get all the solid matter, digging it with a knife if necessary. Then take a strong egg-beater of the dover type, and stir the paint vigorously. If the egg-beater is washed immediately in turpentine or kerosene, it will not be harmed for kitchen use. This will be found a great improvement over the tiresome and unsatisfactory method of stirring with a paddle.

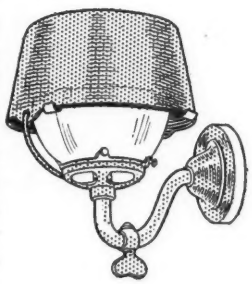
An Ice-Card Holder

A SIMPLE holder for ice-cards or milk-tickets is shown in the accompanying diagram. The holder is made from a strip of brass bent as shown and fastened to the window frame with several tacks. The card is inserted between the strip and the frame, and may be secured with a brass clip.



A Home-Made Gas-Jet Heater

THE accompanying sketch shows a simple way of quickly warming a room from an ordinary gas jet with an ordinary two-quart kitchen dish and three picture hooks. If the latter are not available a piece of iron wire can be bent into the characteristic "S" shape of the picture hook and serve equally well.



Bend the wider sweep of the hooks down so that each will grip the lower edge of the inverted dish more firmly and place the other end of each over the top edge of the shade. The hooks should be spaced about equally around the shade and should be movable until the dish is securely gripped in place, care being taken not to move the hooks into a position where they exert too much pull on the shade or are in danger of letting the dish tip over. With the ordinary shape of two-quart dish and gas shade, the picture hooks will be found just about the right length to afford a firm, satisfactory setting of the inverted dish as shown.

The prompt heating effects of this simple arrangement are quite startling in a moderate sized room. This is chiefly due to the downward deflection of the heat by the sides and top of the inverted dish. The action is independent of the radiation afforded by the surface of the heated dish, as well as of the heat received from the circulation of the air currents which go up to the ceiling and thence are reflected down again.

If a clean, bright dish is used the reflection of the heat rays downward will be considerably increased. The latter will also serve as a light reflector so that a comparably small flame will furnish heat and also sufficient light to read by, which the metal drums usually sold for this purpose will not do.

To Remove Paint Spots From Windows

PAINT spots may be readily removed from window glass by means of an old safety razor blade fastened in a slit of a wooden handle by means of two screws. The handle should be about 8 inches long, 1 inch wide, ¼ inch thick, and cut so as to fit the hand. This paint remover is used like the ordinary paint-scraper.

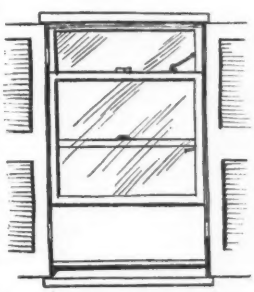
Wire Broom Holder

A VERY effective and simple device for holding a broom is made of heavy wire and fastened to the wall or some other convenient place, by two screw-eyes, the eyes forming bearings for the wire.

To hang up the broom insert the handle into the large eye about four or five inches. The weight of the broom keeps it in position.

Holding a Window in Place

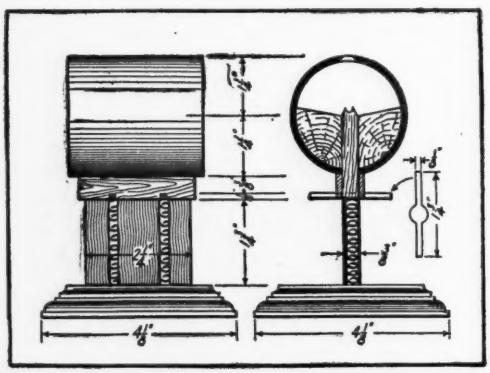
WINDOWS that are not provided with weights and pulleys can be held up with a hook. The hook should be placed in the wood casement adjoining the window and an eye screwed into the top of the window frame. The upper section of the window can be held up by means of a nail driven below the frame.



How to Make a Match Holder

One of those fancy match holders that pass out matches one at a time may be made by any boy who has a knack for handling tools. The accompanying drawings show how it is done. The whole thing may be made of mahogany or any other hard wood and its ornamentation is limited only by the skill and ingenuity of the craftsman.

The match holder is circular in shape and the inside length is the size of the match, plus ⅛" for clearance. The sides are made in two parts and are hol-



How to make a holder that will pass out one match at a time

lowed out so that the thickness of each is about ¼". The ends are ½" thick and are cut to a 2" circle.

When the parts are made place the barrel temporarily and mark the size of the pedestal on the underside and the space through which the pedestal is to pass in carrying the match to the outside. These holes should be carefully cut out when the barrel is ready to be glued together. The inside size of the open box should be that which will fit the pedestal exactly. The cross bearers for the spiral springs to rest on are cut 1¾" long and the breadth of the outer ends are ¼".

Glue the rectangular and the circle part of the barrel together and fit the cross pieces for the springs in position. In fitting together the various parts of the model take the two cross pieces for the springs out of the barrel. Slip into place on the barrel the pedestal which has been detached from the base. The cross pieces for the springs are then put in position from the under end of the pedestal. The springs are next put into the sockets and the pedestal screwed to the base.

Fill the match space three-quarters full, and to use, grip the ends of the barrel, press downward, and a match will come through the aperture in the barrel.

The match holder can be made without the wire springs, but the barrel holder must be lifted up as high as it will go and then allowed to slip down again before the match is obtained.

Some Stain-Removing Recipes

A good general stain remover, which is practically a bleaching agent, may be made from the following formula:

Prepare a 20 per cent. solution of acetic acid. One part of strong vinegar mixed with four parts of water may be used for this solution, which should be labelled No. 1. A second solution should be made by dissolving 5 grams of bleaching powder in 100 cubic centimeters of boiling water. Continue the boiling until a pink color appears. Filter this solution and add 50 cubic centimeters of cold water. Label this preparation No. 2.

To remove stains apply No. 1 until the spot is thoroughly wet. Absorb the superfluous liquor with a blotter and apply No. 2. Rinse and repeat the application if necessary.

Medicine stains on spoons may be removed by rinsing in weak sulphuric acid. Acid and grass stains may be removed by using solutions No. 1 and 2 as described above. For grease spots liberal applications of gasoline, or equal parts of ammonia and alcohol will act as efficacious removers. Paints and varnishes may be made to disappear by using turpentine or benzine; although the former should not be applied to silks. Ink-stains, mildew spots, dye-stains and tar may be readily removed by the use of solutions No. 1 and 2 as above.

Lengthening Life of Window Shades

If glue, instead of tacks, is used in attaching a window shade to the roller, a much neater job can be done, and the shade will not be torn if it is accidentally pulled down too far.

What a Woman Should Know About Electric Connections

The average woman's knowledge concerning the electric current which is supplied to her home is usually vague. When she goes to the stores to buy appliances, the clerk often asks her whether the current is alternating or direct, and a surprisingly small number of women are able to answer correctly. This she should learn from the electrician or electric company.

Few women are able to replace a fuse which has burnt out, and spend dark hours waiting for an electrician to repair the slight damage. She can buy fuse plugs for a few cents and can replace them herself. The mica top of the ordinary fuse plug shows at once which one is burnt out.

Many stenographers are able through long practice to become most familiar with the various types of typewriters, and are able to make slight repairs when their machines are out of order, but should you ask her a question as to the voltage or current in her home, she is unable to answer intelligently.

The simplest method of acquiring a little knowledge of this subject is to read the information plate which will be found on the meter. This gives valuable information in regard to the voltage, the size lamp that should be used, and other facts that every woman should know.

Leatherette Book Covers

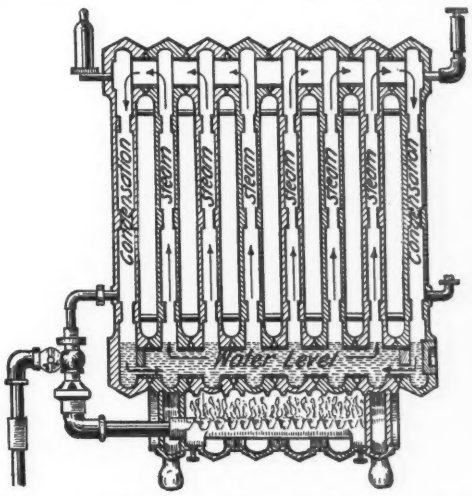
With a little ingenuity, some leatherette upholstering material, glue, and a squeegee roller, very neat looking, handy, and serviceable covers may be made for drawings, note-books and snap-shot photograph albums. The cover may be made best on the loose-leaf note book principle, or may be made to cover a paper-bound book. By studying how any book is bound, it is easily seen how to go about making the cover. When it has been shaped and glued, the whole should be placed between two smooth boards and clamped for 10 or 12 hours.

Fire Extinguisher Liquid

Calcium chloride 30 oz.; salt 5 oz.; water 75 oz. Mix and fill thin spherical bottles with the liquid and seal. Dash the bottles into the fire.

Gas Heated Steam Radiator

How the ordinary steam radiator can be converted into an independent heating unit, thus eliminating expensive boilers and piping, is shown in the accompanying illustration. The radiator is combined with a heater designed to burn artificial or natural gas which is fed into the burner beneath the radiator from the regular gas mains. A few quarts of water are poured into the radiator through an opening provided for the purpose, and a short while after the burner is lighted, the water is converted into steam. The two end sections of the radiator, which extend beyond the heating area of the burner, act as condensers for collecting the water and returning it to the reservoir at the base. By means



How to make an excellent gas heater out of an ordinary steam radiator

of the thermostat shown at the left, the pressure can be regulated within the limits of five and fifteen points. Thus, when the pressure of the steam reaches a certain point, the valve supplying gas to the heater automatically diminishes the size of the flame in the burners. As each heater in this scheme is independent of the others in the house, one can heat any room at any desired time.

A Handy Whetstone

The carbon from a dry battery can be used as a whetstone and will give a very fine edge. A suitable handle may be placed on the brass screw which is found on the end of the carbon.

Damper Opened Automatically by an Alarm Clock

An automatic damper regulator may be constructed at home which helps avoid the trouble of attending to the steam heater when it is necessary to turn off the draft.

An old alarm clock, or one that can be purchased for less than a dollar, forms the principal and most expensive part in the mechanism. In fact, as may be seen from the drawing, the only other materials required are two medium sized spools, a small pulley, a few feet of picture wire, some small iron wire, several pieces of board and a few nails and wood screws.

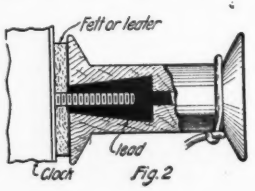


Fig. 2

The first step is to fasten a spool to the alarm spring stem in place of the hand key. Hollow out the spool at one end in order to form a square cavity of larger diameter at the inner end than at the outward extremity. This cavity must be of a depth sufficient to receive the projecting shaft of the alarm spring, the size of which can be measured by removing the hand key. A reasonable allowance of space is also necessary for the hot lead which will have to be poured into the spool around the shaft in order to connect the two parts rigidly.

As soon as the spool is ready, a washer of felt or leather is cut out and placed over the projecting stem of the alarm spring close to the clock case. The clock is then turned over on its face and the spool put in position over the extremity of the shaft, and sufficient lead or other suitable solder is poured in through the upper end of the spool around the shaft. After the lead has hardened, the washer should be cut away as otherwise it would act as a brake on the spring.

As a necessary precaution a loop of small iron wire may be passed around the spool at its inner end and twisted around as shown in the illustration. This will prevent the spool from splitting. One extremity of the wire is bent in the form of a hook which will be connected to the end of the wire which actuates the damper and the other end of the wire loop will be forced into the spool in order to keep it steady. When once the clock has been prepared, a wooden clamp may be used to fasten it to the lever.

The clamp in question can be made as follows: Cut a strip of board of about ⅞", large enough to overlap the diameter of the clock, approximately 2" on each end, shape the board in U form for setting the clock in it. Also prepare a small strip of about ½" stock cut to the same dimensions as the U-shaped board and drilled with a hole at each end to take wood screws about one inch in length. A little hole is next bored to permit the wire from the damper to pass.

When mounting the clock on the steam regulating lever, space should be allowed to permit easy access to the main-spring, winding key and setting key. The clamp must be so fastened around the clock that its front end will be below the lever while its rear end will be above.

To connect the apparatus to the damper a loop is made on the piece of picture wire which will be slipped over the hook on the winding spool and passed down through the hole in the binding strip, thence around a pulley on the front damper and up to the end of the steam regulating lever. A small spool should

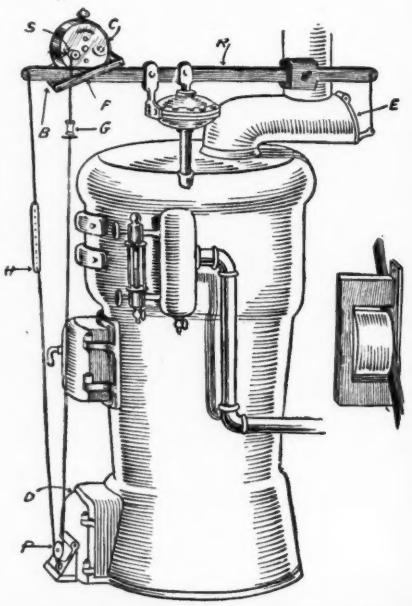
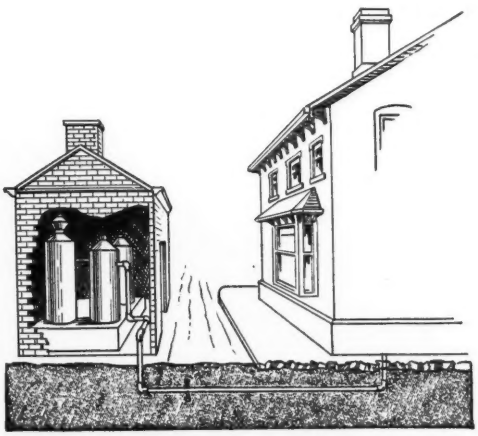


Fig. 1—Arrangement of alarm-clock damper regulating scheme

be put on this wire and several loops made in the wire at a point just below the clamp which must be determined by trial. By passing a nail through these loops in the wire the spool will act as a stop and prevent the clock from opening the damper more than the required amount previously determined.

To Drain Underground Pipes

An acetylene gas plant utilized for lighting a house is located in a small detached building. The main gas pipe runs from the machine under the ground, passing beneath a cement walk, and then up to the house, forming a large U. The lights burned very poorly, and it developed that water had entered the pipe. Since no drip had been put into the pipe, it would have been necessary to tear up the concrete walk to open it, but this difficulty was overcome as follows:



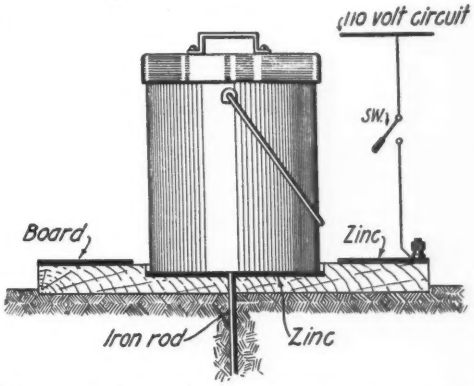
Openings in the gas pipe at its lowest point enable one to clean the pipe with no trouble

A hole was dug near the gas house in the earth which covered the pipe, and a hole was drilled completely through the pipe. This allowed all the water to escape. The hole was then tapped and two bolts were screwed into the holes at the top and bottom. The work was only a matter of fifteen or twenty minutes and the pipe can now easily be drained at any time, with little excavation and no work on the pipe. This device is thoroughly practical and an important aid to the home worker.

To Discourage Prowling Cats and Dogs

No more need people be bothered with troublesome dogs and cats upsetting rubbish or garbage cans. The shocking device shown in the picture will stop this trouble permanently.

The base is made of a circular piece of wood with a margin of about 9″



The encircling plate completes the circuit when a cat reaches to open the garbage can

around the can. A circular space is cut out in the middle ¾″ deep, and slightly larger in diameter than the can. At the bottom of this hollow is placed a zinc plate with an iron rod soldered to the middle of it. The rod runs through a hole bored in the middle of the base; this is for the ground current. The rest of the base is covered within 1″ of the can with zinc which has a binding post attached to it.

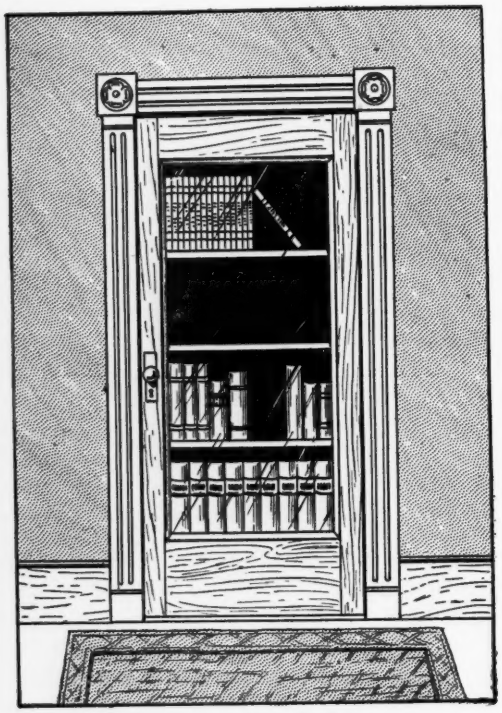
When the device is set up, it is placed on damp ground, or else a wire run to a water pipe underground has to be used to attach to the iron rod. The rod is then driven into the earth. A line is run from one wire of the house lighting circuit to the binding post, using a switch between at some convenient place to shut off the current in rainy weather.

A dog or cat must put its front feet on the encircling zinc. When it touches the can it completes the circuit and receives a shock. It will not injure the animals in any way.

A person can not get a shock unless he deliberately wets his feet and stands on the encircling plate. No electricity is used until some animal closes the circuit as described.

Closet Converted Into Magazine Case

A closet which is not in use can be easily converted into a convenient library for magazines. The panels of the door should be chiseled out carefully, together



An old closet makes an attractive bookcase

with the inside molding. The four inner corners should be braced with metal "L's." A section of clear window glass may be fitted into the door from the inside. Space between shelves for standard sized magazines should be a little more than 12". The magazines are always readily accessible.

A Simple Waterproofing

An excellent waterproofing substance can be made by mixing the following substances in these proportions:

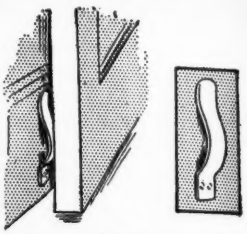
Milk, 10 parts.
Flour, 4 parts.
Molasses, 5 parts.
Wood alcohol, 2 parts.

How to Remove Indelible Ink

Wet the stained portion of the material with chloride of lime and afterward rinse in a little ammonia or sodium hyposulphate and water.

Three Ingenious Door-Checks

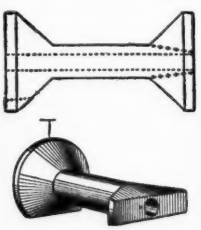
A GOOD door-stop may be easily made from a piece of clock or phonograph spring about 8" or 10" long, or even less. Use a small punch in making a hole in each end of the spring, which may be fastened by small screws or nails at the point where the door strikes the wall-board.



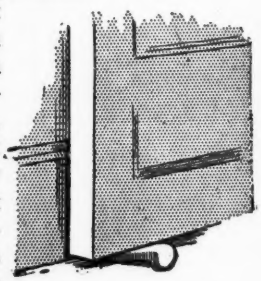
After fastening one end, bend or bow the spring slightly before fastening the other end, thus making the middle of the spring protrude from the wall so that it is struck by the door first.

The above arrangement has been found to be very satisfactory, as it keeps the door-knob and other parts of the door from injuring the wall.

For another simple door-check, take a spool (large or small, according to use required) and cut along the lines marked (+). Trim both top and bottom from front end only a small piece from rear end at the bottom, as per sketch. This will be found a very simple door-check, and may be painted to make it inconspicuous.



An excellent door-stop, which combines both durability and inexpensiveness, can be made out of the ordinary track spike. It forms a solid immovable stop, as shown in the sketch; and although it is recommended for use on concrete floors, it may be also adapted, by wrapping it in felt, for use on wooden floors as well.



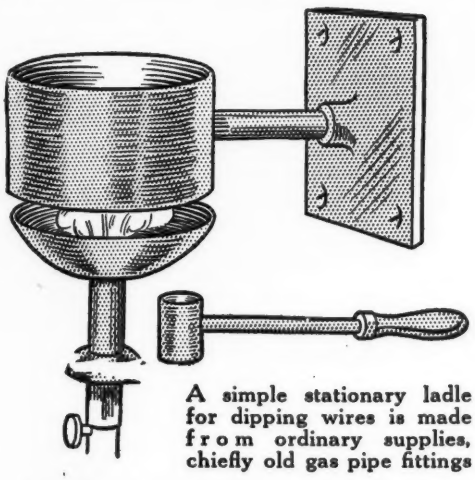
To Make Lacquer for Brass

A useful and durable lacquer for brass on electrical instruments can be made by dissolving as much celluloid as possible in a small amount of banana oil of the kind used for gilding purposes.

For Practical Workers

Stationary Ladle for Dipping Wires

For dipping wires and small objects in molten lead or other metal, the stationary ladle shown in the sketch has been used by a western experimenter. A 2" iron cap, such as is used to close up gas pipes, is attached to the wall by means



A simple stationary ladle for dipping wires is made from ordinary supplies, chiefly old gas pipe fittings

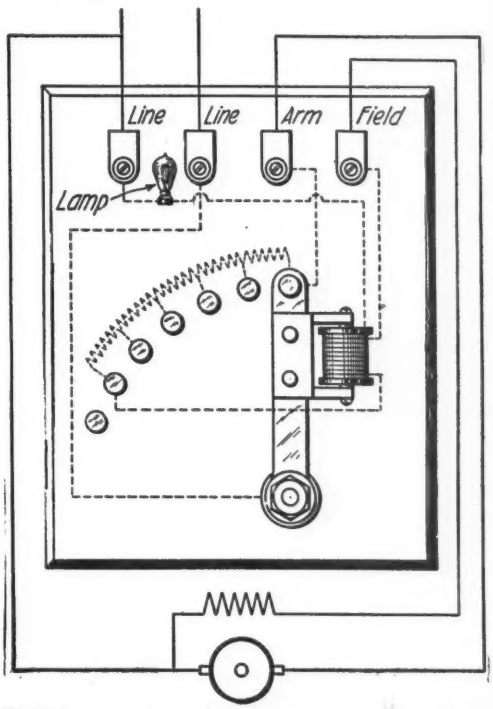
of a ⅛" iron pipe and flange. The hole for receiving the supporting pipe is drilled in the side of the cap close to the top.

A Bunsen burner or the fittings of an old Welsbach mantle will serve very well as the heating element, and a cone-shaped piece of tin slipped over the burner will bring the flame near the bottom of the receptacle, as well as protect the flame from gusts of air. It will serve, in addition, to concentrate the heat.

A small ladle for hand use can be similarly made from a ⅜" gas cap, into the side of which a rod and handle should be screwed.

Repairing a Starting Box With a Lamp

The starting-box shown in the illustration had a defective series coil in the no-voltage release. Repairs were required immediately; and inasmuch as no new coil was then available, a 25-watt 220-volt tungsten lamp was inserted in series with the magnet coil as shown in the figure. The lamp gave a resistance of 1,947 ohms, and the defective coil's resistance was 1,800 ohms. Thus the lamp did not heat the magnet coil; while at the same time it furnished light for the shop.



Utilizing an incandescent lamp to repair a defective series coil

Generating Gases in Large Quantities

There have been described from time to time in these pages, many pieces of apparatus for generating gases such as hydrogen, sulphureted hydrogen, etc., but only for comparatively small quantities or for individual use. The one about to be described is suitable for a busy laboratory. The apparatus need be charged but once a month, or, if for private use, once in two or three months or even less often, according to the amount of gas used.

In the figure *A* and *B* are two aspirators, or bottles, with an extra neck at the bottom. *A* can be raised up to *C* or placed on a table at *D*. *B* contains a layer (*E*) about 2 inches deep, of broken glass or stones, or, in fact, any substance not affected by the acid. The top layer (*F*) consists of the substance to be acted upon, viz., sulphide of iron. The bottles *A* and *G* are filled with diluted hydrochloric acid (1:3).

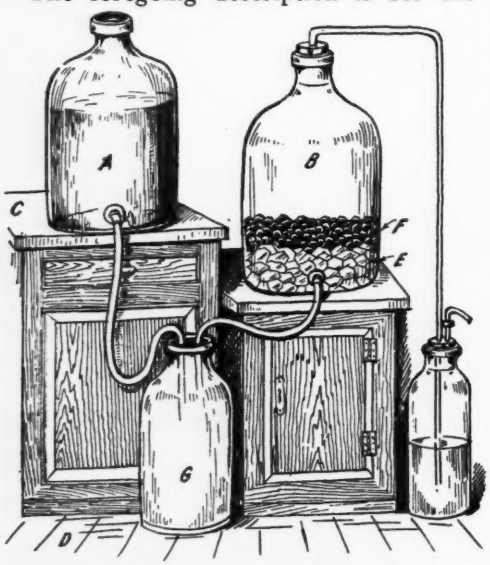
The advantage in this apparatus lies in the addition of the bottle *G*, which makes it possible to use very much more acid and to charge less frequently than would be the case if *A* and *B* were directly joined. When the apparatus is not in use it is advisable to lower the bottle *A* to the bench, although not absolutely necessary.

The foregoing description is for the generation of sulphureted hydrogen gas, but the same apparatus will serve equally well for the following gases:

Hydrogen. Dilute hydrochloric acid in *A* and *G* and zinc or iron at *F*.

Carbonic Acid Gas. Dilute hydrochloric acid in *A* and *G* and broken marble chippings at *F*.

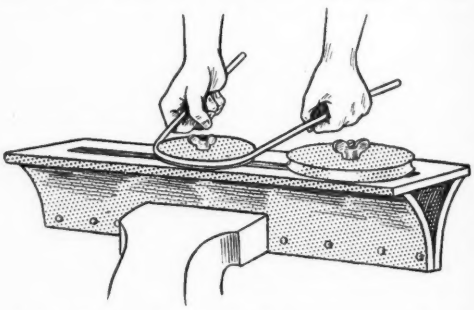
Nitric Oxide. Dilute nitric acid (2:1) in *A* and *G* and copper scrap at *F*.



Large quantities of gases can be generated without continued attention by means of this home made apparatus

A Tool for Bending Tubing

A device for bending tubing and pipes is show in the illustration. Two sheets of iron ⅛" thick are bent as shown, and riveted together at their lower ends. Across the top should be riveted a piece of sheet iron of the same gauge as the other two, and having a slot running lengthwise wide enough to admit ⅜" bolts. A set of grooved wheels are now to be made up of the size required for the particular needs. Each wheel is furnished with a ⅜" hole, so as to admit the bolt which is to fasten it to the slotted plate. The bolts should be long enough to extend from beneath the face place, through the slot and the wheel, and to project about ¾" above the wheel. The latter can now be made secure to the plate by means of a nut, and the whole tool gripped in a vise at its lower end. When the tool is thus in place in the vise, and a wheel fastened to the plate, tubing or piping can be readily bent around the grooved wheels.



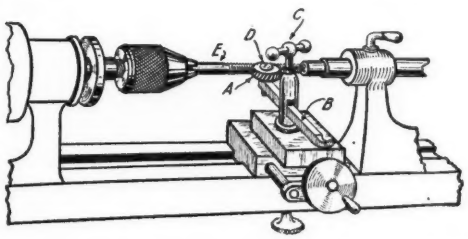
A simple but rigid and effective tool for bending tubes and piping

Show Card Ink

A good ink for show card writing can be made of asphaltum, 2 oz; venice turpentine, 1 oz; lampblack, ½ oz, oil of turpentine, 8 oz. Mix well.

Home-Made Worm Wheels and Screw

The amateur mechanic who frequently requires a worm wheel and screw can easily construct this apparatus from readily obtained materials. First procure a brass disc of the proper thickness and of a diameter a trifle larger than the finished wheel. After drilling the hole for the shaft, lay the disc on the flat end of a lathe-tool, and screw it to the tool so that screw fits snugly in the hole, permitting the disc to turn freely without any lost motion. Now take a tap, *E*, of the required pitch and insert it in the drill chuck of the lathe, so as to bring the disc against the tap. By manipulating the feed screw of the slide rest, the tap will gradually cut a thread on the edge of the disc as the latter revolves. To make the worm screw, take a piece

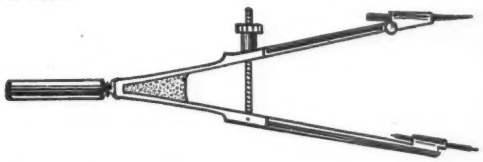


A worm wheel and screw made from readily obtained materials

of piano wire of the proper thickness and wind a close spring, *F*, that will just fit over the shaft. Then stretch the wire so that it will have the same pitch as the tap *E*. When cut to the required length and mounted on a shaft, the wire makes an excellent worm-screw.

Cushion Spring for Compasses

A very useful kink for a draughtsman is shown in the accompanying sketch. It is often found that a bow pen or pencil, especially one that has been used for considerable time, will not spring open quite as far as desired although the adjusting screw is fully slackened and no amount of bending or springing seems to help matters. If, however, a small piece of rubber about ½" x 3/16" x 3/16" is cut from an ordinary pencil eraser and forced up between the legs of the compasses where they join at the top they will be forced out some distance, the rubber acting as an auxiliary cushion spring, which, while giving the compasses a capacity for drawing larger circles, in no way interferes with its use for small work.



A simple auxiliary compass spring made from a rubber eraser

An Open Circuit Telegraph System

In building a telegraph line with a friend, the writer desired to use an open circuit system operating on dry batteries. After numerous experiments he devised the method shown in the diagram below. The line is of the ground-return system. One terminal of the battery is connected with the line, and the other is connected with the key, which leads to the ground. The sounder is connected with the ground and the line.

In using a Eureka combination telegraph set, the wiring below must be altered, as in the diagram. The circuit switch should be removed from the key, as it is unnecessary, and if accidentally left closed would exhaust the power of the battery. An extra binding post is added. Wires are run from the sounder to the line and the ground and from the key to the ground, while battery wires are connected with the line and the key.

The advantage of this system are apparent. The use of dry cells in place of wet batteries is much cheaper, cleaner and simpler. Either party may call at any time. There is no switch to handle when changing from receiving to transmitting and vice versa. No battery is used at the receiving end, the current coming altogether from the sending station.

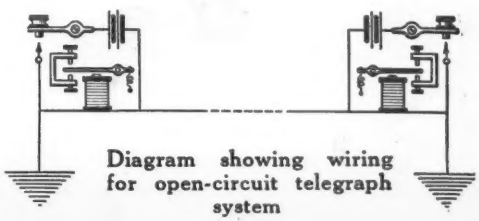
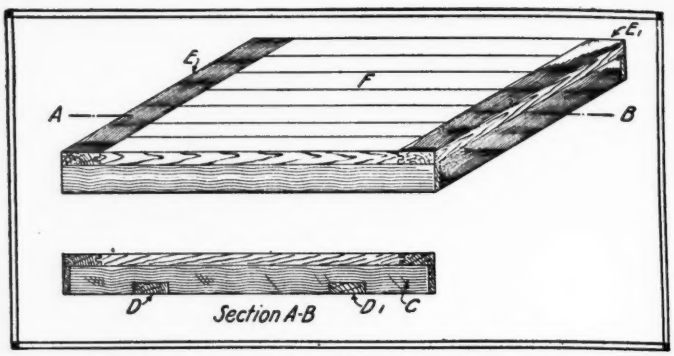


Diagram showing wiring for open-circuit telegraph system

Substantial Top for Work Bench

Heavy carpentry and machine work requires a bench built rigidly and solidly. The legs may be braced easily enough, but a solid, enduring top cannot be improvised. By the use of maple flooring and old two-inch boards a very substantial work bench top can be constructed. Sufficient two-inch planks of the correct length should be secured, and these should be glued and doweled together to form the desired width. When the glue is dry, the bottoms of these planks should be cut out to admit the strips, *D* and *D*1. They should then be glued and securely screwed to the planks *C*. The two-inch boards edging the bench-top should be trimmed with saw and plane on the edges and strips of the half-inch maple flooring nailed along them. Next the strips of flooring, *E* and *E*¹ should be nailed to the two-inch planks with the grooved edge toward the inside.

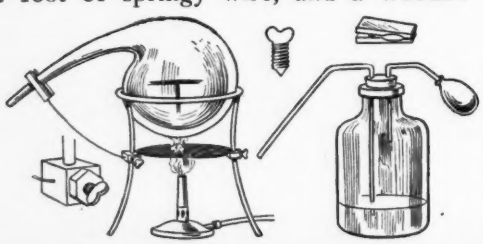


Details of the construction of a work-bench top

The flooring should be laid lengthwise starting with the piece *F*. As flooring is supplied with only one end tongued, the other end must be tooled to fit the grooves of the cross pieces *E* and *E*¹. When the floor is laid, it should be planed smooth and sandpapered. It should be finished with two coats of boiled linseed oil and two of shellac.

Helps for the Chemist

For steadying a retort on a tripod, a spring attachment as shown in the sketch can be easily constructed. Procure a piece of square brass rod about ⅜" long, a foot of springy wire, and a wooden clip such as are attached to trouser hangers. Drill a hole, a little larger than the diameter of the tripod leg, through the piece of brass rod; then drill two additional holes at right angles so as to meet the first hole. Solder a small hexagonal nut over one of these latter, and screw a small wing-bolt into the nut. Solder the wire into the hole drilled lengthwise, as shown in the diagram. Make a depression in each jaw of the clip and glue a piece of felt to each depression. Then solder the clip to the other end of the wire. Slip the small brass rod over the leg of the tripod and fasten the clip to the retort tube, after tilting the latter to the desired angle. The spring wire will hold the retort firmly against jar and vibration.



Simple helps for the chemist

Frequently a siphon ceases to flow at the critical moment. This difficulty can be guarded against by inserting a small glass tube bent as shown into the stopper, and providing a rubber bulb at its outlet end. By squeezing the bulb several times, the siphon will readily start again, a scheme worth all its trouble in making.

To Mark Gauge Glasses Neatly

In all places where gauge-glasses are seen, one often sees two or three strings tied around the glass. This means of telling accurately the reading of the gauge is unsightly and gives an appearance of inefficiency. A much neater and more business-like appearance may be secured by taking rubber washers and placing them on the glass. These may then be slid up or down.

Hardening and Tempering Steel Tools

THE amateur workman and experimenter who uses tools such as screw-drivers, cold chisels, etc., often finds that some of them need to be retempered, as with the best of care some will prove too hard for the average run of work, and a piece will break out. Any amateur by following these instructions will be able, with a little practice, to temper a cold chisel or a screw-driver so that it will give good service. Those who do a little blacksmithing and forging can also make many articles and give them the proper temper for the work they have to do.

If a tool has a fair-sized piece broken out, it will have to be annealed first. This is best done by heating it to a cherry-red color and then burying it into ashes or lime, making sure that they are dry. Cover the tool completely so that no air can get to it. Leave in the ashes for 24 hours, or until cold. Take out and grind on an emery wheel or a grindstone to the shape desired, having the cutting edge ground ready for service. Before a tool can be tempered it must be hardened.

This is done as follows: The tool is put into a coke, soft coal or a hard coal fire, as may be convenient. Turn over occasionally so as to heat it evenly. When it is a cherry-red color, take out of the fire with a pair of tongs (which may be bought cheaply at any hardware store) and plunge into a two-gallon crock containing salt water, enough salt being added to the water to make it taste strongly.

The tool should be held in a vertical position to avoid warping when put into the water for hardening, and moved around in it until cold. It also should be plunged only half-way into the solution, thus leaving the shank hot, while the point is cold. After hardening, rub the point or edge with a file, a piece of firebrick, or a piece of emery cloth tacked on a block of wood. This is done so the color can easily be seen, the color traveling from the hot shank towards the point. When the desired color reaches the point the tool is then completely submerged in the salt water.

The tempering colors follow, each representing a lower degree of hardness than the preceding. Straw color is the hardest, then comes brown, light purple, dark purple, deep blue and pale blue. Straw color is suitable for cold chisels where there are very light blows struck, or for other work where great hardness is desired. Where heavy blows are struck, it is best to temper the chisel to brown. Screw-drivers should be colored a light purple, and springs or other articles that do not require to be very hard, a deep blue. If desired, the tool after tempering may be polished with oil and fine emery paper. When the hot metal is plunged into the salt water bath for hardening it will make a snapping sound. The salt, besides making the steel very hard, also cleans it from dirt and scale left by the fire, the tool having a silvery-white color when withdrawn from the solution.

There are a number of different chemicals used by blacksmiths for hardening, among them being cyanide of potassium, which is a deadly poison and should not be used by amateurs. The plain salt bath will be found to suit all amateur requirements; in fact, a large number of professional temperers prefer it to the cyanide solution.

The foregoing instructions for tempering tools are for the bought article damaged by use. To the embryo blacksmith who desires to make his own cold chisels, etc., purchasing the steel necessary for the work, it must be pointed out that steel bars are made containing different amounts of carbon, and as the latter element confers the property of hardening and tempering upon steel tools, it will be advisable to select a metal having a suitable carbon content.

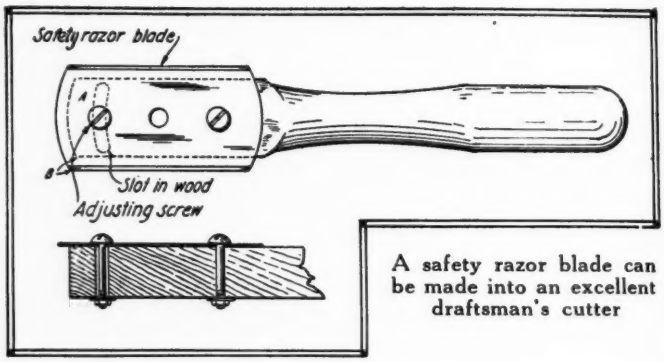
From .9 per cent. to 1.1 per cent. carbon will be found to be best for all-around work. Here is a list showing the amount of carbon desirable in steel for various work: .5 per cent. carbon for battering tools, .7 per cent. for hot work, .8 per cent. carbon for wood-cutting chisels and some forms of reamers, .9 per cent. carbon for cold chisels, drills, taps, dies, and reamers, 1.25 to 1.58 per

cent. carbon for lathe tools, graving tools, scribers, scrapers and small drills. Steel containing low amounts of carbon, such as .15 per cent., will not temper. The amount of carbon in the bar has to be suited to the work to be done when made into tools.

Thus, a high-carbon steel crowbar of 1 58 per cent. carbon, no matter how carefully tempered, would be brittle compared to a crowbar made of .9 per cent. carbon steel, the latter being able to withstand far more rough usage and give better service than the high carbon one. The amateur worker in steel can get considerable enjoyment as well as instruction by tempering the tools that he works with, experience proving that it will always come in handy when anything goes wrong with tools, which sooner or later, always occurs with the best in the market.

Adjustable Drawing Trimmer

A simple and easily made drawing plate trimmer is shown in the illustration. A safety razor blade is clamped to a suitable handle of wood, the slot at *A*, as indicated by the dotted line, is to permit the angle of the cutting edge to be changed at will. The width *B*, of the cutting edge, must be adjusted according to the thickness of the tee-square that is being used as a straight edge.



A safety razor blade can be made into an excellent draftsman's cutter

A Handy Reamer

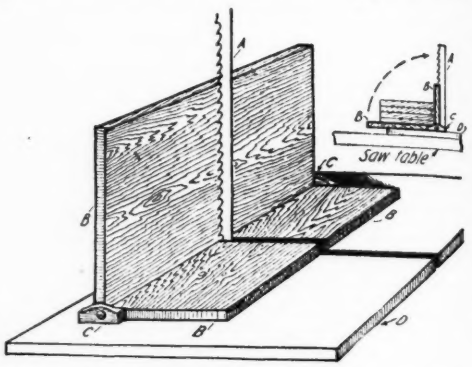
An old file or rasp will often be found handy in the workshop to ream holes in wood or metal. When the hole desired is not too large, the end of the file may be put into a brace, and the pointed end used as a reamer. For larger holes, reverse the ends of the file in the brace. Reaming from both openings will improve the quality of the hole considerably. After reaming, the holes should be finished with a fine rat-tail file.

To Tap a Hole in a Corner

A hole in a corner can be tapped by the use of a ratchet brace.

Cross Cutting Gauge for Band Saw

A band saw may be used for cross-cutting light lumber if the attachment shown in the accompanying drawings is employed. The supports *B* are pivoted at both ends and the stock *E* put in place as shown. When the supports and



How a band-saw can be guided to cross-cut light lumber

stock are swung slowly upward, the saw cuts through smoothly and accurately. The pivots, *C*, *C*, should be bolted to the saw table at a sufficient distance from the teeth, so that the back is not cut through.

Cement for Mending Steam Boilers

Mix two parts of finely powdered litharge with one part of very fine sand, and one part of quick lime which has been allowed to slack spontaneously by exposure to the air. This mixture may be kept any length of time. In using it a portion of it is mixed into a paste with linseed oil or, better, boiled linseed oil. In this state it must be quickly applied, as it soon becomes hard.

Overhauling Your Car for the Winter

By Victor Pagé

MANY car owners recognize the value of having the car overhauled before the inception of the active riding season, when climatic conditions are not favorable to the continual operation of the car. In those portions of the country where cars may be kept in operation all the year round, a certain time each year should be set apart for giving the car a thorough looking over with a view of determining the points where depreciation exists, and best methods of remedying the defective condition. The wise motorist realizes that this work of restoration is absolutely necessary if continued satisfactory service is to be expected from the car. The motorist who shuns the expense of having the machine looked over, and who operates it as long as the various parts function, is generally the one who is loudest in the condemnation of the automobile. In this article the writer discusses various steps incidental to overhauling gasoline engines of various types.

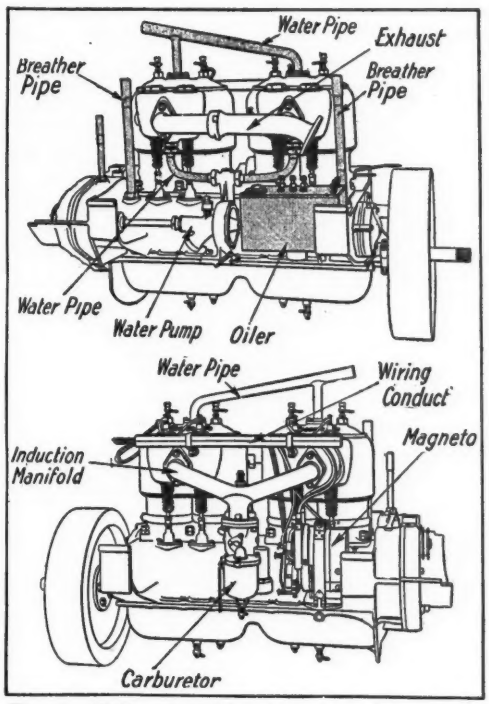


Fig. 1. Exhaust and intake side of locomobile four-cylinder motor

In taking down a motor the smaller parts and fittings, such as spark plugs, manifolds and wiring, should be removed first. Then the more important members, such as cylinders, may be removed from the crankcase to give access to the interior and make possible the examination of the pistons, rings and connecting rods. After the cylinders are removed the next operation is to disconnect the connecting rods from the crankshaft and to remove them and the pistons attached as a unit. Then the crankcase is dismembered, in most cases by removing the bottom plate, thus exposing the main bearings and crankshaft. The first operation is the removal of the inlet and exhaust manifolds, next one uncouples the water piping from the radiator. There are various methods of fastening manifolds on the cylinder casting, the most common being by retaining stirrups, or by flanges and bolts, as outlined in illustrations of engines at Fig. 1. As will be evident, where cylinders are of the T-head form, with valves on opposite sides of the cylinder casting, the bolt and flange system is generally used. On L-head motors, where the valves are in the same extension of the cylinder casting, the bolt and stirrup retention method is generally followed. One may safely say that engines of low and moderate - priced cars, being of the L-head form, will have the manifold retained by stirrups and bolts, whereas the T-head power plant of the larger and higher-priced cars will use the bolted manifold construction.

It is now common practice to cast all cylinders together, blocks of four being very common and blocks of six are not rare enough to cause comment. In some cases the manifolds are cored integral with the cylinder casting, and it is merely necessary to remove a short pipe leading from the carburetor to one inlet opening and the exhaust pipe from the outlet opening common to all cylinders. In order to remove the carburetor it is

necessary to shut off the gasoline supply at the tank and to remove the pipe coupling at the float chamber. It is also necessary to disconnect the throttle operating rod. After the cylinders are removed, and before taking the crankcase apart, it is well to remove the water pump, magneto, and mechanical oiler if that system of lubrication is used. The wiring on most engines of modern development is carried in conduits, and usually releasing two or three minor fastenings will permit one to take off the plug wiring as a unit. The wire should be disconnected from both spark plugs and magneto distributor before its removal. The appearance of the engine shown at the bottom of Fig. 1, after the magneto ignition wiring, spark plugs and front of timing gear case are removed, is shown at Fig. 2, B. The next operation in dismantling this engine is to take off the four nuts holding the induction manifold to the cylinder castings and when the manifold is removed the carburetor comes with it. The appearance of the engine after this has been done is shown at Fig. 2, B. The next parts to be taken off, the cylinder castings, are shown in this view.

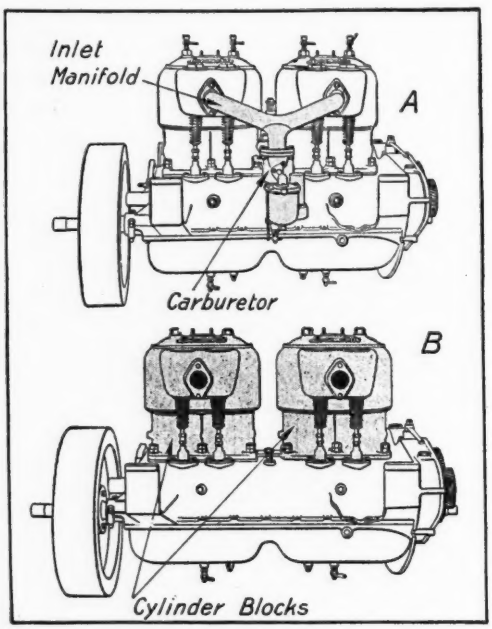


Fig. 2. Illustrating steps in removing motor parts when dismantling power plant

Before disturbing the arrangement of the timing gears it is important that these be marked so that they will be replaced in exactly the same relation as intended by the engine designer. If the gears are properly marked the valve timing and magneto setting will be undisturbed when the parts are replaced.

When an engine has been taken down it is impossible to ascertain if there is any undue wear present in the connecting rod bearings at either the wrist pin or crank pin ends, and also to form some idea of the amount of carbon deposits on the piston top and back of the piston rings. Any wear of the timing gears can also be determined. The removal of the bottom plate of the engine enables the repairman to see if the main bearings are worn unduly. Often bearings may be taken up sufficiently to eliminate all looseness. In other cases they may be worn enough so that careful refitting will be necessary.

All engines are not of the type shown at Fig. 1. Where the crankcase is divided horizontally into two portions, the upper one serving as an engine base to which the cylinder and, in fact, all important working parts are attached, the lower portion performs the functions of an oil container and cover for the internal mechanism. There is a tendency on the part of modern designers to combine the cylinders and a portion of the crankcase in one casting, using a detachable cylinder head construction in order to permit valve grinding and carbon removal without taking the engine out of the chassis frame. The connecting rods and pistons may also be removed where this construction is followed through the opening left after the detachable cylinder head is removed.

The important parts of an engine of the conventional four-cylinder pattern, where the cylinders are cast in pairs, are clearly shown at Fig. 3, and their appearance may be readily noted. It will be evident that when the bottom of the crankcase is removed the crankshaft is exposed, and the main bearing caps may be released by unscrewing the bearing cap retention bolts.

In some multiple cylinder engines the

cylinders are cast individually, and instead of the crankshaft having three main bearings, as is often the case, it has five main bearings, as indicated in the sectional view of the Overland engine shown at Fig. 4. When the cylinders are cast individually it is possible to replace a defective cylinder without sacrificing the remainder, as is imperative if the cylinders are cast in block. Individual cylinders are more easily handled, but where these are used it is absolutely necessary to mark them so that they will always be replaced in proper position. In most cases the cylinders are duplicates of each other, and if they were not marked it would not be difficult to transpose them on the engine base, an undesirable proceeding.

One of the most widely used of automobile power plants, and one that practically all repairmen will have occasion to work on at some time or other, owing to the thousands in use in all parts of the world, is that employed on the Ford Model T automobile. This power plant is shown in part sectional view at Fig. 5. It is a unit power plant, as the planetary change speed gearing is carried in an extension of the engine crankcase. The four cylinders and upper portion of the crankcase are cast as a unit. The cylinder head is removable. One of the novelties of construction in this motor is the use of a flywheel magneto, the balance member carrying a series of U-shaped magnets which revolve past a series of fixed field coils attached to a plate which does not rotate on account of being bolted to the engine crankcase. The general construction of the engine may be readily ascertained by careful inspection of the illustration.

Defects in Cylinders.—After the cylinders have been removed and stripped of all fittings they should be thoroughly cleaned and then carefully examined for defects. The interior, or bore, should be looked at with a view of finding score marks, grooves, cuts or scratches in the interior, because there are many faults that may be ascribed to depreciation at this point. The cylinder bore may be worn out of round, which can only be determined by measuring with an internal caliper or dial indicator even if the cylinder bore shows no sign of wear. The flange at the bottom of the cylinder

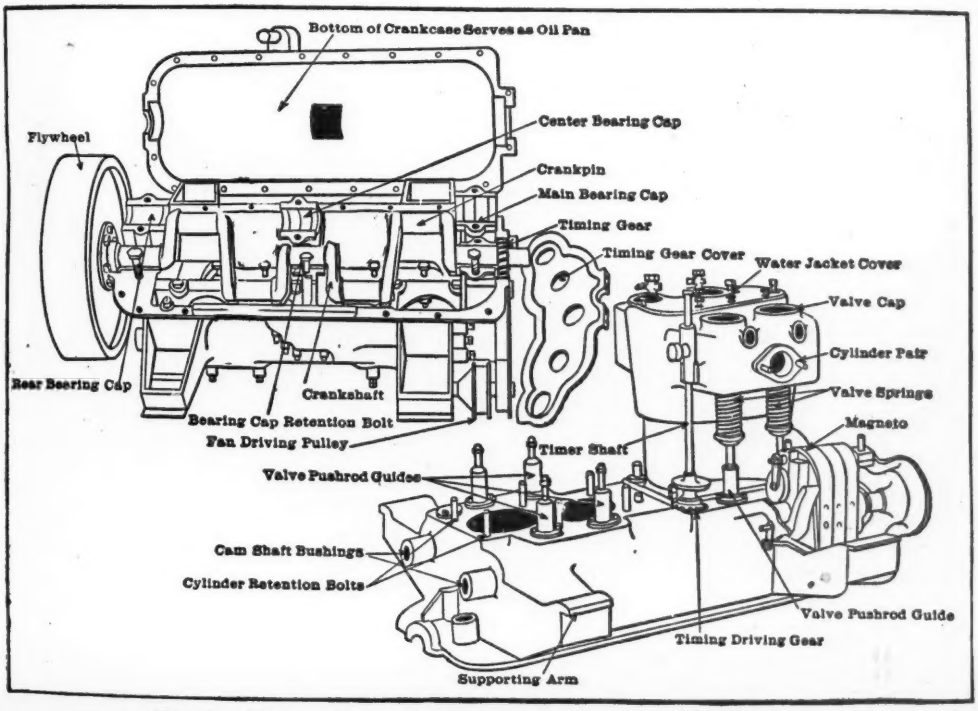


Fig. 3. Views of a partially dismantled automobile engine

by which it is held to the engine base may be cracked. The water jacket wall may have opened up, due to freezing of the jacket water at some time or other, or it may be filled with scale and sediment due to the use of impure cooling water. The valve seat may be scored or pitted, while the threads holding the valve chamber cap may be worn so that the cap will not be a tight fit. The cylinder described is an individual casting of the L-head form having integrally cast water jacket.

Other forms of unit cylinders have been evolved, one of the most widely used being that of the four-cylinder Cadillac engines. This incorporates several novelties in construction, one being the applied sheet copper water jacket, the other being the detachable cylinder head casting which is screwed down against the top of the copper water jacket and held in place on the cylinder by an externally threaded close nipple. An advantage which is being claimed for this construction is the easy replacement of one defective cylinder assembly part without scraping the rest. With the Cadillac construction, should the water jacket be faulty it is impossible to repair this easily, owing to the material employed, or to replace it if repairs are not practical. If the cylinder should be scored, the water jacket and combustion head may be saved and a new cylinder casting purchased at considerably less cost than that of the complete unit cylinder.

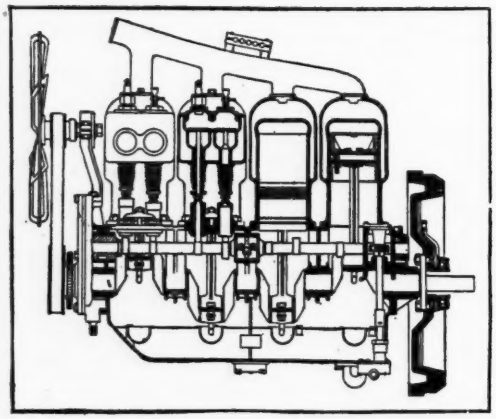


Fig. 4—Longitudinal view of Overland four-cylinder motor, a type having individual cylinder castings and a five-bearing crankshaft

The detachable head construction has only recently become popular, though it was one of the earliest forms of automobile engine construction. In the early days it was difficult to procure gaskets or packings that would be both gas and water tight. The invention of the copper-asbestos gasket, which is composed of two sheets of very thin, soft copper bound together by a thin edging of the same material and having a piece of sheet asbestos interposed, solved this problem. One of the first engines to use the detachable cylinder head piece was the Ford, and at the time it was first introduced it was met with considerable criticism on the part of automobile engineers. That this proved unfounded and based on personal prejudice is clearly demonstrated at this time by the wide use of the detachable head construction. Copper-asbestos packings form an effective seal against leakage of water and a positive retention means for keeping the explosion pressure in the cylinder.

The great advantage of the detachable head is that it permits of very easy inspection of the piston tops and combustion chamber interiors, which can only be done with cylinders of the L or T form by removing the cylinder from the engine base. Two forms of removable cylinder heads are shown at Fig. 6. They are similar in design and utilize the same form of gasket, the only difference being that the type shown at *A* serves two cylinders, while the one outlined at *B* covers the four cylinders. The construction at *A* is used on the Oakland car, while that at *B* is found on the Ford, Metz, Regal, Carter-car, Maxwell, Oakland and several others. The cylinder heads are securely held by substantial retention bolts, and if these are properly tightened and the gasket is in good condition there is not likely to be any loss in pressure due to leakage. One of the most important things to look for when the cylinder has been removed or the cylinder head taken off, if that method of construction is followed, is carbon deposits. These accumulate at the piston top, valves, around the spark

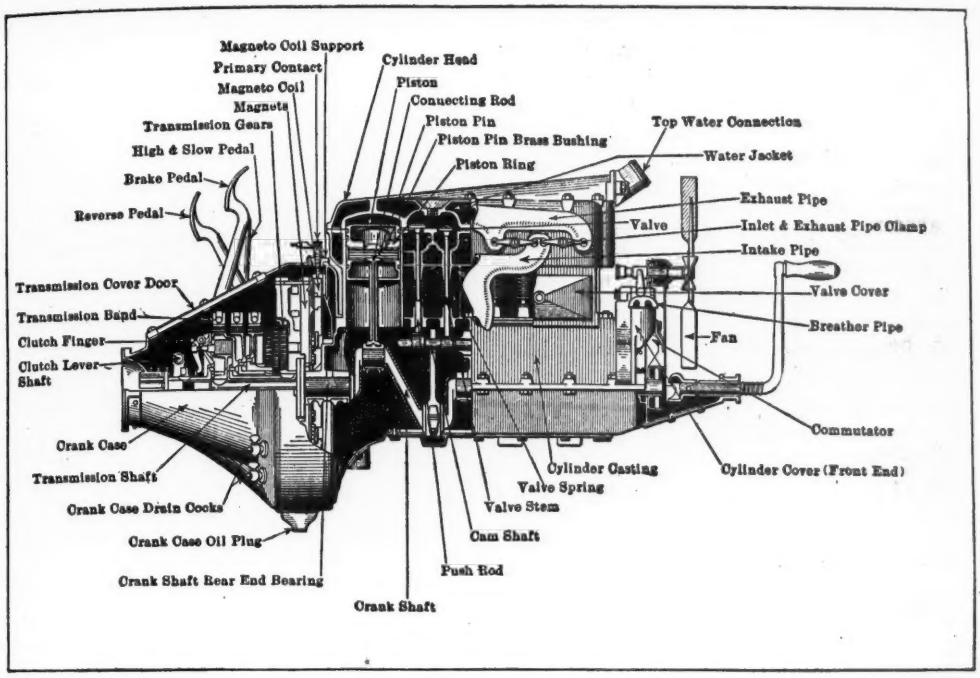


Fig. 5. Phantom view of the Ford four-cylinder unit power plant

plug and at several points in the combustion chamber.

Carbon Deposits, Their Cause and Prevention. — Most authorities agree that carbon is the result of imperfect combustion of the fuel and air mixture as well as the use of lubricating oils of improper flash point. Lubricating oils that work by the piston rings may become decomposed by the great heat in the combustion chamber, but at the same time one cannot blame the lubricating oil for all of the carbon deposits. There is little reason to suspect that pure petroleum oil of proper body will deposit excessive amounts of carbon, though if the oil contains a resinous or animal fat filler there would be much carbon left in the interior of the combustion chamber. Fuel mixtures that are too rich in gasoline also produce these undesirable accumulations.

Fully 50% of this deposit can be attributed to the ordinary dust of the highway and not to excessive fuel or an impure grade of lubricating oil. While it is imperative to use as little gasoline in the mixture as possible, and to supply only the proper quantities of high-grade lubricating oil, it will be evident that even if these precautions were carefully observed there would still be considerable deposit as the result of the impurities drawn in through the carburetor. It is very good practice to provide a screen on the air intake to reduce the amounts of dust sucked in with the air as well as observing the proper precautions relative to supplying the proper quantities of air to the mixture and of not using any more oil than is needed to insure proper lubrication of the internal mechanism.

Use of Carbon Scrapers.—It is not unusual for one to hear an automobile driver complain that the car he drives is not as responsive as it was when new after he has run it but very few months. There does not seem to be anything actually wrong with the car, yet it does not respond readily to the throttle and is apt to overheat. While these symptoms denote a run-down condition of the mechanism, the trouble is often due to nothing more serious than accumulations of carbon. The remedy is the removal of this matter out of place. While the surest way of cleaning the inside of the motor thoroughly is to remove the cylinders, if these members are cast integrally with the head, or of removing the head member, if that is a separate casting, to

expose all parts, there are other methods that have been recommended that may be depended on to reduce the amount of carbon deposits. A number of carbon solvents of a secret composition have been offered which may be introduced into the cylinder through the spark plug openings or valve cap holes that are said to soften the accumulation and permit it to be blown out through the exhaust when the engine is again started after the material is used. The writer believes that there is more or less "fake" about these compositions, as chemical analysis of some has disclosed the composition, which, on careful study of cause and effect, does not seem to justify all the claims made for them by the enthusiastic advertising men responsible for their promotion. One widely advertised carbon remover of liquid form was found to be composed largely of acetone. Another was practically deodorized kerosene and denatured alcohol mixture. Another of granulated form was discovered to be practically common salt. There is no question in the writer's mind but that a solvent like acetone would soften carbon deposits enough so it could be readily removed by scraping.

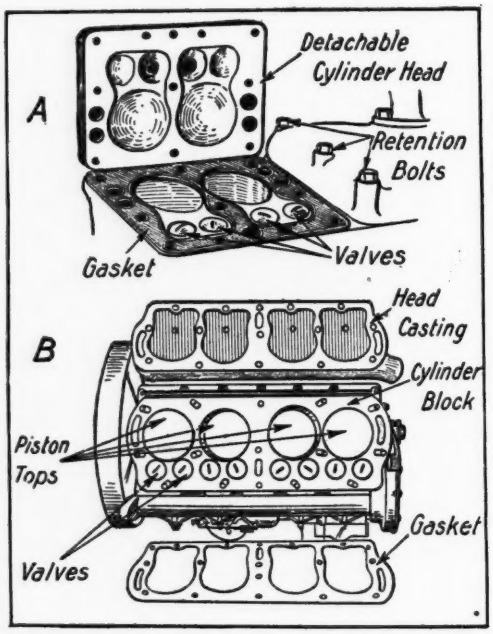


Fig. 6. Showing utility of detachable cylinder heads and how they make for superior accessibility of valves and combustion chambers

In certain forms of cylinders, especially those of the L or T form, it is possible to introduce simple scrapers down through the valve chamber cap holes and through the spark plug hole if this component is placed in the cylinder in some position that communicates directly to the interior of the cylinder or to the piston top. This method is particularly applicable to engines having valves on opposite sides, namely those employing cylinders of the T form. No claim can be made for originality or novelty of this process as it has been used for many years on large stationary engines. The first step is to dismantle the inlet and exhaust piping and remove the valve caps and valves, although if the deposit is not extremely hard or present in large quantities one can often manipulate the scrapers in the valve cap openings without removing either the piping or the valves. Commencing with the first cylinder, the starting crank is turned till the piston is at the top of its stroke, then the scraper may be inserted and the operation of removing the carbon started by drawing the tool toward the opening. As this is similar to a small hoe, the cutting edge will loosen some of the carbon and will draw it toward the opening. A swab is made of a piece of cloth or waste fastened at the end of a wire and well soaked in kerosene to clean out the cylinder. When the engine is of a T-head type and the valves are removed it is possible to introduce a ball of waste at one part and push it clear through the cylinder and out of the other valve port, this bringing much loosened carbon out with it.

When available, an electric motor with a length of flexible shaft and a small circular cleaning brush having wire bristles can be used.

Repairing Scored Cylinders.—If the engine has been run at any time without adequate lubrication one or more of the cylinders may be found to have vertical scratches running up and down the cylinder walls. The depth of these will vary according to the amount of time the cylinder was without lubrication, and if the

grooves are very deep the only remedy is to purchase a new member. Of course, if sufficient stock is available in the cylinder walls, the cylinders may be rebored and new pistons which are oversize, *i. e.*, larger than standard, may be fitted. Where the scratches are not deep they may be ground out with a high-speed emery wheel or lapped out if that type of machine is not available. Wrist pins have been known to come loose, especially when these are retained by set screws that are not properly locked, and as wrist pins are usually of hardened steel it will be evident that the sharp edge of that member can act as a cutting tool and make a pronounced groove in the cylinder. Cylinders that have been damaged in this manner have sometimes been repaired by the autogenous welding process, the oxy-acetylene flame being used to fuse new cast iron into the groove, then grinding out the ridge of excess material in order to obtain a smooth bore. Cylinder grinding is a job that requires skilled mechanics, but may be accomplished on any lathe fitted with an internal grinding attachment.

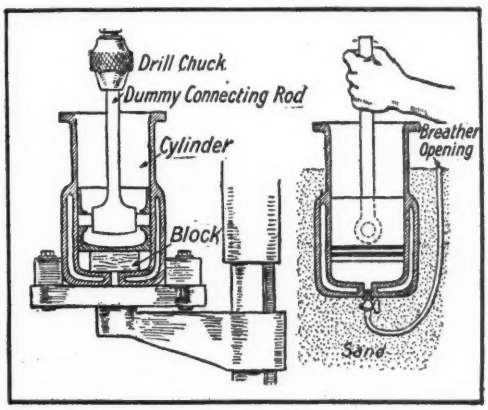


Fig. 7. Outlining use of dummy piston and connecting rod for lapping out fine scratches in cylinder bore

When a car that has been used for a considerable length of time is overhauled it may be found that the cylinder bore will have worn enough so reboring will be necessary. The wear is commonly found about midway the length of the cylinder walls, as it is at this point that the connecting rod side thrust is greatest, due to the angularity of that member. In order to remedy this defective condition some repairmen are content with merely fitting new piston rings of slightly larger circumference, but this plan is not wholly satisfactory, because if the rings are of sufficiently small diameter to enter the unworn portion of the bore when they spring out into the worn part there must exist too wide a gap at the slots. For this reason most mechanics prefer to fit either a new cylinder and piston or to rebore the cylinder and fit a larger piston with correspondingly larger rings.

If the car is an old one and it is not considered wise to spend the money necessary to restore the cylinder bore to correct shape, one can get considerably more service by a simple expedient of making new piston rings with long stepped ends. In this case they will pass the smaller portions of the bore and expand sufficiently to fill the worn parts. As there is no gap between the ends, even when fully expanded, there will be but little loss of compression, such as might be possible with either butt joint or diagonal cut rings under the same conditions. One precaution is essential, however, and that is to insure that the grooves are of sufficient width to take step cut rings having substantial steps. If the piston rings are narrow, the ends are apt to snap off at the steps. If the grooves are turned out to a greater width, new piston rings must be made to fit. The compression is much improved and power is increased as the rings with the long-stepped joint will follow the worn bore, constricting as the bore is smaller and filling out as the wear increases.

Where the grooves in the cylinder are not deep, or where it has warped enough so the rings do not bear equally at all parts of the cylinder bore, it is possible to obtain a fairly accurate degree of finish by a lapping process in which an old piston is coated with a mixture of fine emery and oil and is reciprocated up and down in the cylinder as well as turned at the same time. This may be easily done by using a dummy connecting rod having only a wrist pin end boss and of such size at the other end so that it can be held in the chuck of a drill press. The cylinder casting is firmly clamped

on the drill press table by suitable clamping blocks, and a wooden block is placed in the combustion chamber to provide a stop for the piston at its lower extreme position. The back gears are put in and the drill chuck is revolved slowly. All the while that the piston is turning the drill chuck should be raised up and down by the hand feed lever, as the best results are obtained when the lapping member is given a combination of rotary and reciprocating motion.

Even if power is not available, the repairman need not be discouraged, because very good results may be obtained by hand lapping. The same method is used as for lapping by power. The abrasive material is composed of very fine emery and light machine oil, and is renewed from time to time and the cylinder cleaned out to remove the old lapping compound before any new mixture is introduced. A cylinder may be easily supported in a box of sand, as indicated, the compression relief petcock in the top of the cylinder being provided with a piece of rubber hose which projects above the surface of the same, and which acts as a breather opening for escape of the air compressed by the downward stroke of the lap.

Where the cylinders are cast in block, as is now common practice on nearly all automobiles of recent development, it is not difficult to hold the cylinder block, as this is of sufficient size and weight to stand upright on the bench without clamping it down. The process of lapping is continued until the entire interior of the cylinder is bright and clean and the scratches practically removed. All abrasive material is then washed out of the cylinder with gasoline and the walls wiped dry with a soft cloth.

How to Repair a Cracked Water Jacket.—The water jacket of a gas engine cylinder will sometimes become cracked, due to freezing of the cooling water, or perhaps as a result of a sand or blow hole which opens up from vibration after the cylinder has been used a while. At the present time the usual practice in repairing cylinders is to fill the depression or crack with iron by the autogeneous welding process, although various iron cements may be used for that purpose if the fracture is not serious. A mechanical repair is always possible, *i.e.*, a metal patch can be applied to cover the crack and held in place against a gasket interposed between the plate and the cylinder jacket by small machine screws tapped into the iron. Where only a small blow-hole exists or a small crack the mechanical method shown at Fig. 8 is possible. This consists of drilling a hole of sufficient size to take a standard pipe plug, either ⅛ inch or ¼ inch, according to the size of the hole, as shown at *A*. A pipe plug is screwed into the tapped hole, as shown at *D*, and when it has been forced in place after coating the threads with red lead and oil or pipe joint compound to insure a tight joint, the projecting portion of the plug may be cut off with a hacksaw as outlined at Fig. 8, *C*, and the remaining portion of the plug filed flush with the outside of the water jacket.

If the crack is of some length it may be repaired by the following method: On the line of the fracture drill and tap for a ⅜-inch threaded copper rod. This rod is screwed in firmly to a depth about equal to the thickness of the metal of the water jacket. Cut off the copper rod with a hacksaw, allowing it to project about 1/32 inch; then drill succeeding holes, each hole being drilled partly into the previously inserted copper plug, so that when all of the plugs are placed in the cylinder casting they form a continuous band of copper along the line of the fracture. The copper plugs should now be peened down and trimmed off flush. The only possible chance for leakage, after having repaired the crack in this manner, is for the water to follow the joint between the metal of the jacket and the copper plugs, but as the copper rods are threaded into the casting, it is not likely to occur. Should leakage take place, a little extra peening will suffice to prevent it.

Still another method involves fusing copper filings or granulated brass spelter into the crack. This has the advantage of not requiring the removal of the part to be repaired. Drill and tap a small hole at each end of the crack to prevent further extension of the weakness, and screw in an iron stud. Next clean the outside and inside of the fracture very thoroughly, using a scraper and gasoline.

File up some soft copper or brass spelter and fill the crack, heaping the filings over it. Then take a powerful blow-lamp or a torch and direct the flame on the copper. By this method a fair amount of metal can be worked into the opening. After cooling the studs are cut off flush and the copper filed smooth. It is said that the repair will last.

In many cases the crack may be closed by making a rust joint. The first step is to drill a very small hole at each end of the crack to prevent it from spreading and to drive in or screw in a metal plug in each hole. The crack is then filled up with a paste made of 66% fine iron filings or iron dust and 33% sal-ammoniac in the pulverized form, with just enough water to make a mixture of proper consistency to be forced into the crack easily. The action of the sal-ammoniac is to rapidly oxidize the fine iron filings, producing rust which joins the various iron particles together and effectively seals the opening when it has properly hardened. As a number of prepared cements for use with cast iron may be purchased at low cost, it is often cheaper to buy the cement than to attempt to make it.

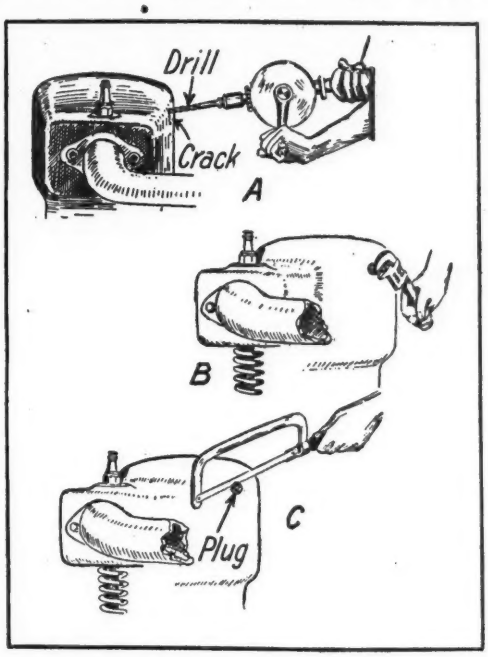


Fig. 8. Method of using pipe plug for sealing fine cracks or sand holes in cylinder water jacket

Inspecting Cylinder Head Packings.—On a number of overhead valve type motors having the valves carried in a removable cage gaskets are used to obtain a tight joint when the cage is screwed down. This packing frequently becomes soft, resulting in a leak around the valve. In multiple cylinder motors the gaskets that are used at the point where the intake manifold joins the respective cylinders should be examined when the manifold is removed to make sure that these are in good condition. The gasket at the exhaust pipe should also be inspected. The packings for the inlet pipe may be of well shellacked cardboard, mobiline or other asbestos packing, or even sheet rubber, but those used on exhaust pipes should only be made of asbestos or copper-asbestos. A defective gasket on the inlet manifold will seriously attenuate the mixture going to all cylinders, while a defective packing under the exhaust manifold joints will have no effect upon the operation of the motor, the only result being a sharp hiss or whistling sound due to the leaky gas.

Engines of the detachable head form have packings that are made of a sheet of asbestos sandwiched between very thin sheets of copper. While these packings have the advantage of not depreciating rapidly, at the same time they may be packed down so solid and be so stiff that they will not allow the cylinder head to bed properly after they have been used for a time. Some cylinders, especially of the individual casting form, have a hole at the top which is used for holding the core during the casting. This hole is usually filled with a plug tightly screwed into it, and the orifice should be tightly sealed against internal pressure or water leakage. These plugs are sometimes made of bronze, and it is not unusual to find that they will leak slightly as they have become loose due to the difference in ratios of the expansion between the iron used for the cylinder and the metal of which the plug is composed. If the cylinder is of this pattern, this plug should be looked over carefully.

A number of cylinder designs, especially those in which four or more cylin-

ders are cast in a block, have a large plate at the side which is used to close the water jacket, this forming a cover for an opening which had been left to facilitate foundry work when the cylinder was cast. This plate is either of sheet brass or aluminum; in some cases it may be an aluminum casting having a portion of the intake manifold cast with it. Leakage is prevented by a packing interposed between the plate and the cylinder.

A Compressed Air Tank

The acommpanyign sketch shows how a beer-keg, a pump, several pieces of piping, and a valve from an automobile tire were used to make a compressed air tank. Three holes were bored in the top cover of the keg. Into one was screwed a valve taken from the inner tube of a tire; and a gauge for indicating pressure was connected with the second hole by means of ¼" piping. The third hole received the pipe and valve for drawing off quantity of compressed air required. Now, with the aid of a good bicycle pump, the barrel could be pumped full of air, just as a tire is pumped up. The valve prevented the escape of air back into the pump. The keg contained 2" of water. A pressure of 150 lbs. was obtained with this device.

Prolonging the Life of the Storage Battery

When storage battery plates begin to sulphate, due to an accidental overcharge or over-discharge, their life may be greatly prolonged by removing the deposit of lead sulphate. This may be done as follows:

First the cell should be fully charged and then the electrolyte siphoned off and pure water substituted immediately. The cell must now be discharged through a resistance, after which the plates may be removed. The white deposit of lead sulphate may now be removed with coarse sand paper, and the battery reassembled with new electrolyte.

The lead sulphate, if allowed to remain on the plates, will cause them to warp or buckle, and will eventually result in an internal short circuit, and ruined plates.

Simple Substitute for Bunsen Burner

A simple but effective substitute for a Bunsen burner, operated by carbide instead of illuminating gas, can be made from materials costing only a few cents. All that is needed is a medium-sized bottle with a large neck, a cork to fit the neck of the bottle, 4" of 1/16" brass tubing, 4" of 3/16" tubing and the cover from a small baking powder can.

The tin cover is intended to hold water and should be soldered to the smaller tubing so that when the tube is run through the cork, the water will drip down into the bottle. Six or eight small holes are drilled in one end of the larger tube, which is bent at an angle, and the other end of this tube also run through the cork.

To operate the burner, fill the bottle about one-third full with carbide, such as is used in acetylene gas generators, put the cork in place, but not too securely, so that it will act as a safety valve in case the burner tube becomes stopped up, and fill the receptacle with water. Gas will immediately begin to generate and by holding a lighted match to the burner it will soon come to a steady flame. The pressure of the gas in the bottle will regulate the flow of the water.

This little device may be used for any purpose for which the ordinary Bunsen burner is employed. It is especially useful in workshops where illuminating gas is not obtainable.

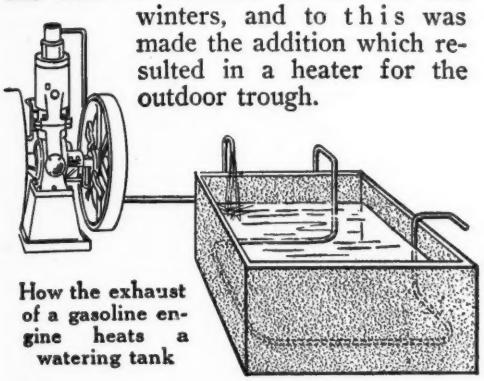
Cement for Steam Pipes

Good linseed oil varnish, ground with equal weights of white lead, oxide of manganese and pipeclay make a good cement for steam pipes.

A Home-made Tank Heater

The illustration pictures a cement trough for watering horses and cattle. It is built on the outer wall of an engine house under a porch roof, which protects the cattle from the weather. Any water left in the trough freezes on cold days.

In the engine house is a 2-h.p. gasoline engine. The exhaust pipe has been run through a discarded hot-water tank and thence out of doors. By this means the tank is heated while the engine is running, perceptibly raising the temperature of the room. This contrivance has been in constant service for two winters, and to this was made the addition which resulted in a heater for the outdoor trough.



How the exhaust of a gasoline engine heats a watering tank

To the exhaust pipe running through the hot-water tank, was added a sufficient length of old gas pipe to carry the length of the house overhead, down the wall and out into the trough. Here it connects with a rectangular pipe-frame which rests on the floor of the trough, the return pipe with a double elbow carrying off the exhaust at one end of the trough as in the diagram.

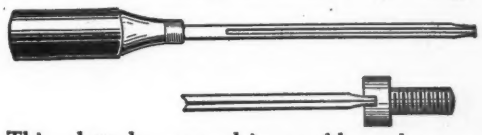
This particular engine runs from 30 to 40 minutes, night and morning, to supply air-pressure for the water system and to run the dynamo which furnishes electricity for the farm. At the same time the exhaust, carried through the described tank and pipes, warms the building and heats the water in the drinking-trough at the times when it is most needed.

Cutting Stove Pipe

Use a can opener to cut stove pipe if you have no large pair of shears. The can opener answers the purpose admirably.

A Slotted Screw Driver

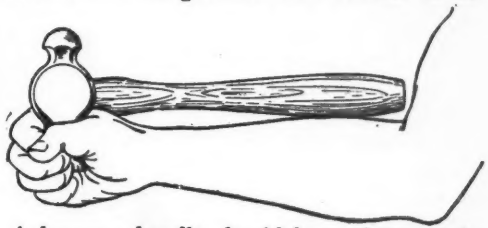
The sketch shows a method of adapting a screw driver so that it can hold a screw while being handled. The magnetized screw driver is often inefficient; besides being useless for brass screws, it loses its magnetism after a little use. By slotting an ordinary screw driver, however, a certain amount of spring is obtained; and when the two prongs are inserted into the head, the screw is very firmly held.



This slotted screw driver seldom drops a screw

To Find How Long Hammer Handle Should Be

A very simple way to get the length of a hammer handle which a machinist should use to get the best results is as follows: Grasp the head of the hammer as shown in sketch. Let the handle rest on the forearm, and the elbow should be at the end of the handle of proper length.



A hammer handle should be as long as the forearm

A Strong Cement for Leather

A liquid cement for leather, one which will not be affected by the action of water, is gutta percha, dissolved in carbon disulphide until it is of the thickness of treacle or molasses. The parts to be cemented should be shaved thin. Pour a small quantity of the cement on both ends, spread it well to fill the pores of the leather, warm the parts over a fire for about a half minute, apply them quickly together and hammer well. The bottle containing the cement should be tightly corked and kept in a cool place, and will keep if cared for.

A Home-Made Filter for Outdoor Use

A good filter that will find favor with campers who desire pure water from streams has been devised by a French physician.

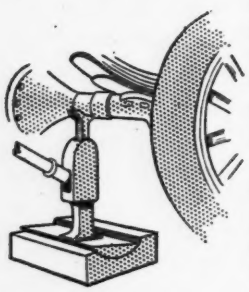
As shown in the accompanying picture, an ordinary tin box is soldered to the bottom of a metal water-pail. The floor of the box is perforated with rows of holes which extend through the pail bottom. A coiled spring attaches the cover of the box to the bottom and is made to pass through a tin tube in the center of the box. Alternate layers of powdered charcoal and well-packed cotton are now placed in the box; and the pail is suspended in a stream.

Gradually, as a result of air pressure, the pail will fill up with filtered water. Then, by loosening the chain, the spring cover drops back on the box, and the pail, full of water, may be lifted out of the stream.

The water may be further sterilized by adding a few crystals of potassium permanganate. A very few crystals, not enough to tint the water, should be used. Potassium permanganate is one of the cheapest and most powerful of disinfectants.

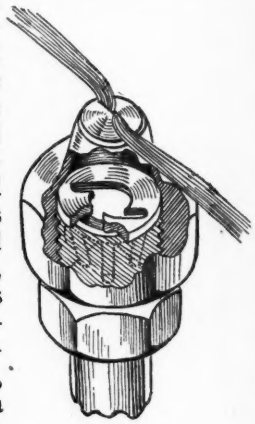
To Keep an Auto Jack Level

Very often, on account of the uneven nature of the ground, it becomes necessary to use some means to keep a jack level when lifting an automobile axle. The device in the illustration presents a simple solution. A block of wood, 8″ square and 2″ thick, is grooved by means of a band-saw so as to cut out a semicircular strip. This is adjustable to any position in the groove; and it may be used to provide a level surface for a jack when the road is uneven.



An Improved Liquid Atomizer

The ordinary atomizer used for supplying liquid fuel to boilers has the disadvantage of spreading the oil in all directions, with a consequent waste of some of the fuel. The device illustrated, however, causes the oil to be sprayed in one plane only, namely, at right angles to the nozzle. The liquid, under heavy pressure and unmixed with air, enters the tip of the nozzle through a small ring-shaped channel. A very rapid whirling motion is imparted to the oil within the nozzle, and as it emerges from the slot separates into two finely-divided sprays, one moving off in a right-hand, and the other flowing in a left-hand direction.



A Rivetless Hoop

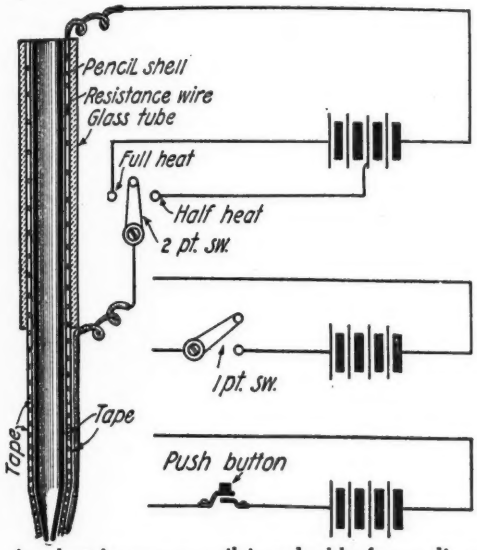
As shown in the accompanying illustration rivets are not needed when making hoops for pails or barrels. The ends of a strip of sheet metal are bent at right angles, so as to resemble the letter Z. The strip is then bent in such a way that the two bent-up ends rest against each other in an interlocking joint. Another strip of metal, about three times the width of the hoop, is then bent into three equal sections and fitted over the joint in the hoop.

Improved Shellac Varnish

Add a teaspoonful of Venice turpentine to a half pint of shellac varnish and it becomes elastic and glossy, and sticks well to polished metal exposed to the weather, and mixes well with dry colors, such as lampblack for a glossy black, and vermilion for red.

An Electric Wax Pencil

In winding coils and armatures, the amateur electrician often finds it necessary, when interrupted in his work, to seal the ends of his wires to prevent their unwinding. The device in the illustration shows a wax pencil which uses an



An electric wax pencil is valuable for sealing wires temporarily

electric current to supply melted wax for just such an occasion and in as varied a quantity as may be desired. The inside parts of an old clutch-pencil of the nickeled or German silver variety are all removed, leaving a metal shell with a clear passage from end to end. Cover this shell with a layer of ordinary tape. Upon this tape, beginning at the pointed end, wind a layer of No. 26 bare German silver resistance wire, spacing each turn 1/16″ from its neighbor. Leave enough wire at the ends to furnish connections to the switch and battery. Wind a second layer of tape over the bare wire; and slip a snug-fitting glass, rubber or metal tube over the pencil to provide a cool grip. Now fill the inside of the pencil with melted wax, which, when hardened, is ready for use. A battery of four cells, connected to this pencil, will cause the wax to melt and flow from the narrow end of the pencil in less than half a minute.

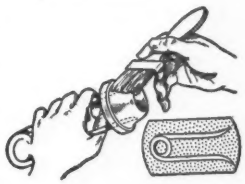
The pencil furnishes an excellent means for sealing wires and for other work where little wax is required.

To Make Copper Oxide for Batteries

An excellent way to make copper oxide for use in batteries is as follows: Take a quantity of copper filings or fine copper shavings and heat them in a cast iron container or in a crucible till they are red hot. Stir them with an iron rod and while still stirring sprinkle a little water over the filings until they become ocher red. You will then have a good quality of copper oxide.

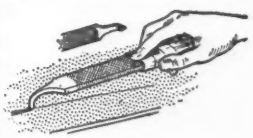
Copper oxide plates may be made as follows: Mix the granulated or coarse copper oxide with 5% or 10% of magnesium chloride and heat the heavy mass in forms, made of iron sheeting, the forms being of the size of the wanted plate. The more chloride of magnesium used, the more porous the plates will be. The coarser the copper oxide, the better will be the results of the process and in the battery itself.

For the Lacquer Man



The device in the illustration is designed to hold small articles that are to be lacquered or dipped, and to prevent soiling and finger marks on the work. A piece of No. 10 steel wire about 18″ long is bent around a piece of pipe so as to form a spring at its center. The ends are sharpened and slightly bent out, and may be used to hold objects when lacquering.

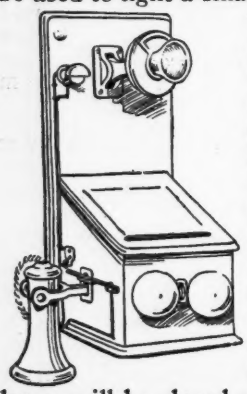
To Make Sharp Corners in Sheet Metal



An old file can be used to make the tool required to enable the amateur mechanic to bend sheet metal at sharp corners. Anneal the handle-end first, and then bend it at right angles, as shown in the sketch. File the point to a right-angled, V-shaped edge. The sheet metal may now be scratched at the desired point with a scratch awl; and with the aid of a point of the file, the scratch can be dragged out and deepened, until the metal can be bent up at a sharp angle.

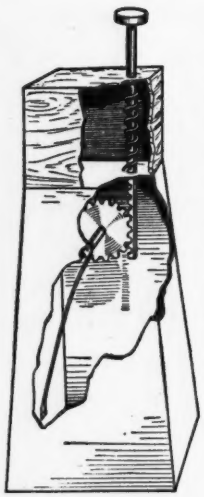
An Automatic Telephone Lamp

The accompanying drawing shows how the ordinary telephone hook may be used to light a small electric lamp conveniently situated so as to aid the user in looking up numbers or taking down information. Fasten a piece of spring brass to a block of fiber and then screw this to the telephone cabinet in such a position that the circuit, including the battery and the lamp, will be closed at the gap when the receiver is removed from the hook and will thereby light the lamp. The strip of spring brass should be insulated from the telephone by gluing to the brass a piece of hard rubber or fiber.



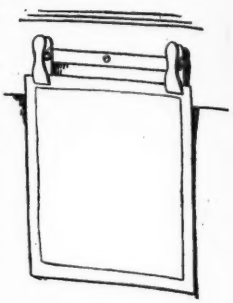
A Home-Made Hand Klaxer

THE accompanying drawing shows how a hand klaxer can be constructed from very inexpensive materials. The horn is made of sheet tin, and is attached to the wooden head. A steel or a brass rod, fitted with a suitable handle, passes through the wooden head, where it is held against the washer by means of a spring. The inner end of the rod is toothed so as to enable it to operate the gear. When the rod is pushed into the horn the gear causes the brass or wooden strip which is attached to the horn to vibrate and to emit the usual klaxer sound. The spring forces the rod out when the pressure on the handle is removed, enabling the operator to maintain a constant production of sound.



A Film-Developing Hint

CLIPS for holding strips of photographic film when developing, fixing and drying can be made from a brass strip as long as the film is wide, with a spring paper clip soldered at each end.

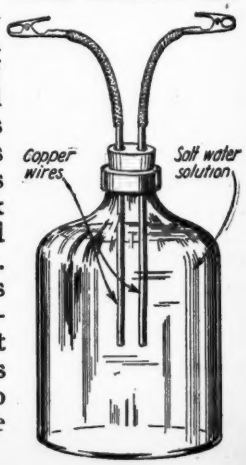


Removing Solids from Filter Paper

With the aid of the apparatus shown in the illustration, sediments and precipitates which accumulate on filter papers may be readily removed. The large flask is fitted with a rubber stopper containing two holes. The longer tube, bent as illustrated, passes through the stopper almost to the bottom of the flask; and a shorter tube also is inserted. A small glass nozzle is attached to the outer end of the larger tube, and by blowing through the short tube a stream of water from the flask is projected against the filter paper, from which sediment is thus washed.

Simple Polarity Indicator

To show the polarity of an electric terminal, an easily made indicator consists of a small bottle containing a strong solution of common salt, and two copper strips immersed in this solution. The strips pass through a cork which is paraffined to prevent leakage. If this device is connected in a circuit, the strip at which bubbles form is known to be the negative pole of the circuit.



RADIO SECTION

Devoted to the Encouragement of Amateurs and Experimenters in the Field of Radio Communication

TO OUR RADIO READERS

The Radio Section in this issue, which is the second under the new editorial policy of the POPULAR SCIENCE MONTHLY, *should be of still greater interest and value than that of last month. The leading article, on "Recent Radio Inventions," by Mr. A. F. Jackson, analyzes the novel features of several devices and methods patented during the last few months, and clearly describes them. Mr. A. J. Watt's resumé of sustained wave generators and receivers in commercial use is concluded, and a number of useful construction notes are given. A series of articles discussing the elementary problems of wireless transmission for both amateurs and professionals begins with this issue. Our new department of Book Reviews is opened this month; in these reviews it is our intention to indicate the scope and usefulness of each publication, from the radio viewpoint, more fully than has been done elsewhere. The Radio Club News department also begins in this number, with an article on organization and conduct of such societies. The Editor will be glad to receive and publish news of the various radio associations throughout the country. "What Radio Readers Want to Know" has proved so helpful that it will be continued as a department; the queries will be answered as accurately and concisely as possible.*

As to the future: It is our intention to continue from month to month the departments on Recent Radio Inventions, Construction Notes, Book Reviews, Radio Club News and Queries. In addition to these, special articles on the applications of radio telegraphy and telephony will appear each month. The Editor will welcome comments from our readers as to the most interesting and useful portions of the Radio Section, as well as suggestions for new departments, and new material for publication.

Recent Radio Inventions

By A. F. Jackson

METHODS of and apparatus for generating sustained waves in radio telegraphy and radio telephony are arousing more and more interest as continuous waves become more widely used. The best known generators are the directly operating radio frequency alternator, of Fessenden, the Goldschmidt reflection alternator, the Joly-Arco. frequency transformers and the Poulsen arc. Marconi's proposal to secure radio frequency sustained alternating current by the successive discharge of condensers has, however, recently been disclosed by the issue of U. S. patent 1,136,447 of 1915. It is stated that the apparatus there described is of the character used in the sustained-wave tests between Clifden and Glace Bay.

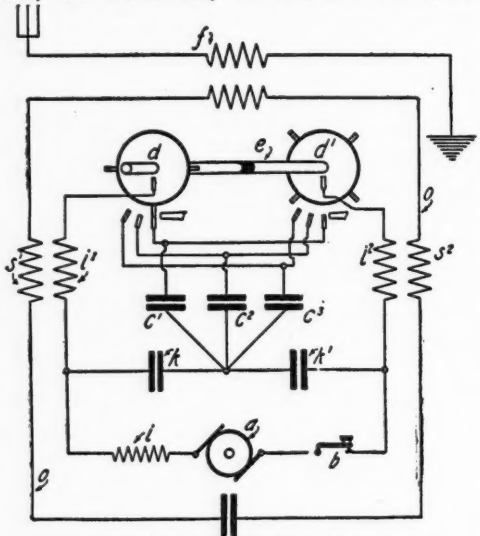


Fig. 1—Marconi method of securing undamped wave

The patent specification illustrates two forms of the new sender, the simpler of which is shown in Fig. 1. In this diagram it is seen that when the key *b* is depressed the source of direct current *a*, acting through impedance *i*, applies a voltage across the serially connected condensers *k*. *k*. The outer terminals of these condensers are connected to the studded insulated discs *d*, d^1, whose contacts are so spaced that the three subordinate condensers c^1, c^2, c^3 are connected between the central point of *k*, k^1 and, alternately and successively, the positive and negative feed wires from *a*. This arrangement results in charging the three sub-condensers successively in one direction through one of the primary inductances (say i^1), then successively discharging them and recharging in the opposite sense through i^2, and repeating. By adjusting the speed of the rotating discs and choosing the proper number of condensers, a synchronous relation with the resonant period of the circuits through the condensers *k*, k^1 the sub-condensers c^1, c^2, c^3, and the primaries i^1, i^2, is reached. The secondary circuit *o*, s^1, s^2, having a series condenser and additional primary coil, is tuned to synchronism with the impulses in the sub-circuits. Thus sustained radio frequency currents are set up in this intermediate circuit, and these, acting inductively on the aerial circuit at *f*, produce the desired continuous waves.

Obviously the same arrangement can be used to generate electromagnetic waves in groups of high or low group frequency instead of undamped radiation.

It has long been known that in radio telephony, for example, speech can be transmitted by the use of waves of very high group frequency. Lee deForest shows, in United States patent 1,125,496, of 1915, a simple method of producing such waves and of using them for wireless telephony. In the diagram Fig. 2, *B* represents an alternating current dynamo of about 3,000 cycles per second, which is connected through transformer *F* to the quenching spark gap *D*, the closed circuit condenser *C* and the primary portion of the direct connected oscillation transformer *G*. The secondary portion of this coil is led to the antenna *A* and to earth *E* through microphone *M*. As used in a practice a condenser is often inserted in the primary side of transformer *F*, for tuning circuit to alternator frequency.

In operation the quenching gap is adjusted to produce a uniform discharge of such high group frequency that the individual impulses scarcely affect the telephone at the receiving station. Talking into the microphone then produces amplitude changes in the radiated waves, and speech is transmitted in the usual way. The novelty of the method seems to lie in the use of the quenching gap at suf-

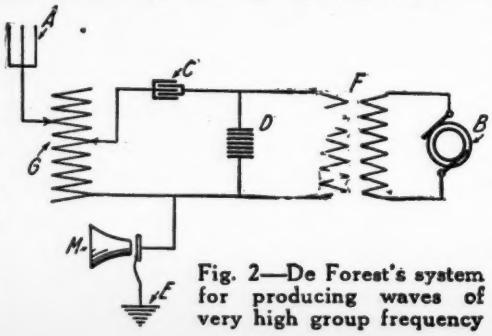


Fig. 2—De Forest's system for producing waves of very high group frequency

ficiently high frequencies for radio telephony.

Wireless telephone transmitters which rely upon carbon microphones to modulate directly the radio frequency current are, of course, limited in output by the power which can be passed through the microphone without undue heating. A device intended to remove this power restriction is the subject of United States patent 1,148,827, issued in 1915 to Walther Burstyn. In this disclosure an electrostatic modulating device, such as shown in Fig. 3, is suggested. Between a series of rigid plates are supported a number of mechanically linked diaphragms *a*. Alternate fixed plates (marked *c* and *d*) are connected to terminals k^2 and k^3, while the diaphragms *a* are connected to terminal k^1. The instrument thus built is placed in circuit at *V* according to Fig. 4, where *e* represents a battery, *m* a microphone, *t* a telephone transformer, *y* an additional polarizing battery, and *f* an antenna excited by radio frequency generator *g* through inductive coupler c^1, c^2.

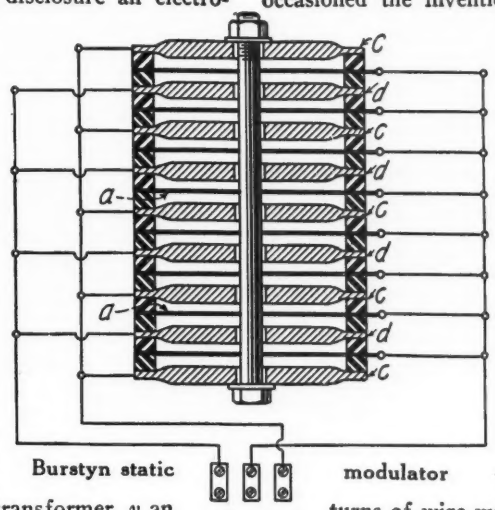


Fig. 3

The operation of this multiple-cell condenser transmitter is quite simple. When the microphone speech-currents act through terminals k^1, k^3 they cause the diaphragms *a* to move to and from plates *d* in accordance with the voice waves. The movements of the diaphragms correspondingly and simultaneously alter the capacity of the condenser formed across k^1, k^3 by plates *c* and *a*. This varying condenser, being connected directly in series with the antenna, throws the aerial system more or less closely in tune with the exciting alternator *g*. The changes in resonant condition thus produced by the voice control the current in the aerial circuit and therefore that in the receiving telephone. So, assuming an amplifying operation by the multiple static transmitter *V*, it becomes possible to telephone by radio over longer distances than could be covered if the microphone were directly in series with the antenna.

A problem quite different from any of these occasioned the invention disclosed in United States patent 1,141,387, granted to Charles S. Franklin in 1915. For many radio stations it is advantageous to limit reception or transmission to a given direction, instead of communicating with equal freedom in all directions. One way of restricting the electromagnetic waves so that their greatest intensity lies in a single vertical plane is to use a magnetic loop antenna. This loop may be one or several turns of wire wound about a supporting framework and vertically mounted. Such an aerial is closely directive for either sending or receiving, but it is not efficient as an antenna. The best arrangement is a single turn enclosing as large an area as possible and having a small variable condenser in series for tuning; with even this, however, it is impracticable to increase the length of the antenna wire enough to make it a really efficient absorber or radiator.

Figure 5 shows Franklin's arrangement for increasing the size of the vertical magnetic loop antenna and still keeping it tuned to the wavelength used. At equal distances around the loop there are inserted series condensers *c*, of such capacity as exactly to neutralize

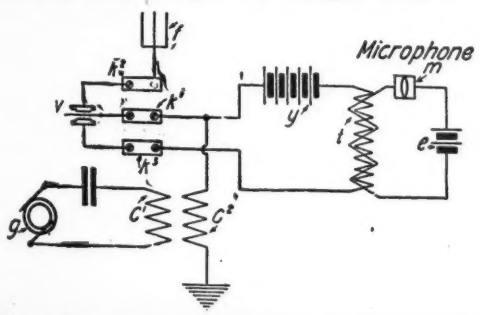


Fig. 4—Burstyn method of increasing the output of the microphone in wireless telephony

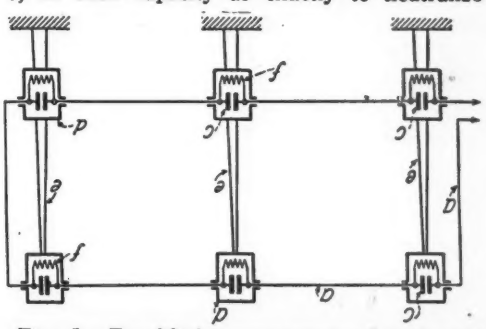


Fig. 5—Franklin's arrangement for increasing the size of the vertical magnetic loop antenna

the inductive reactance of the aerial wire *a* adjacent to it, so making the entire aerial system resonant to the wavelength employed. The condensers are to be placed in waterproof cases *d* along the wires, and to be shunted by leak-coils of high impedance *f* to prevent slow static charges from collecting. This new antenna system is stated to be not only quite sharply directive in either sending or receiving, but also a very powerful radiator or absorber of electromagnetic waves.

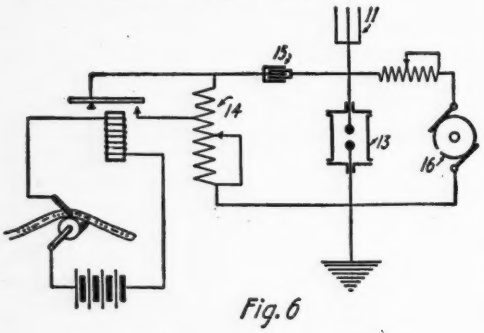


Fig. 6—Fessenden tape sender

United States patent of 1915, No. 1,132,568, issued to R. A. Fessenden for "Electric Signaling," contains some interesting suggestions for high speed automatic radio transmission and reception. Telegraph signals sent out at say 100 words per minute by a sustained wave generator controlled by an automatic punched-tape transmitter are received by a "heterodyne" or beats receiver. The signal-note pitch is adjusted to say 5,000 per second, and the received messages recorded at this high, shrill note upon a wax cylinder or a telegraphone wire. The phonographic record thus made is then reproduced at about 1/5 the recording speed, or 20 words per minute. At the reduced speed the signal-note frequency is also reduced 1/5, of course, or to 1,000 per second. The most interesting point is that "strays," or atmospheric disturbances, are recorded originally at their characteristic frequency of 4 or 5 per second; when the record is reproduced slowly the effect of the strays is reduced, and the pure signal tone of 1,000 groups per second may easily be read by the transcribing operator. A type of sender proposed by Fessenden is shown in Fig. 6, where the tape sender is seen to control radiation from the compressed air gap *13* which is supplied by power from generator *16* and excites the aerial *11* through the oscillation circuit *14, 15*. The receiver may be as indicated by Fig. 7, in which the received-wave currents in coil *26* interact magnetically with the locally generated current from alternator *29* so as to produce a heterodyne tone from the diaphragm *27*. The recording phonograph and attachments are represented by *30, 40, 41* and *42*.

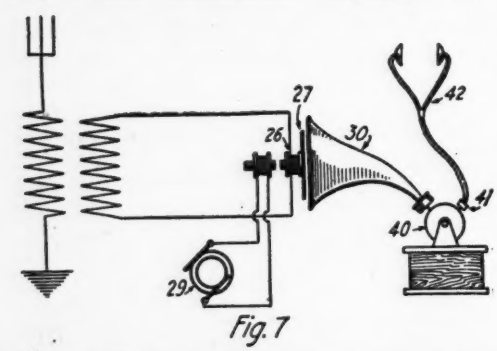


Fig. 7—Fessenden receiver using recording phonograph

Aerial for Two-Inch Coil

An aerial 160 feet long, 60 feet high and consisting of but a single wire would be well proportioned for use with a two-inch spark coil if there were no radio laws, but it will be necessary to cut it down to 100 feet if the operator were to come within the 200 meter law. The wave length of this aerial would be about 250 meters.

With a two-inch spark coil, a rotary spark gap would be preferable.

Radio Equipment for the University of Washington

Plans are well under way for the installation of a complete radio engineering laboratory at the University of Washington, Seattle, in the near future. An antenna 800 feet in length has been built, extending from a water tower, 230 feet in height, to the Engineering building on the Campus. Receiving apparatus of the latest type, including audion equipment fitted with Armstrong circuits, for the reception of both damped and continuous waves, has been installed, and more is being added.

During the present year transmitting apparatus will be built by students and will be counted as thesis work. This apparatus will be in conformity with the highest standards in radio engineering and will include both the spark and arc excitation type of transmitters.

Professor Magnusson, head of the Department of Electrical Engineering, is supervising the work, and will be assisted by Messrs. E. C. Miller and F. M. Ryan, students attending the university.

Transmitting Condenser

About fifteen 5" x 7" plates would be required for a glass condenser to use with a ½ kilowatt transformer, but the actual number of plates used would vary with the particular conditions.

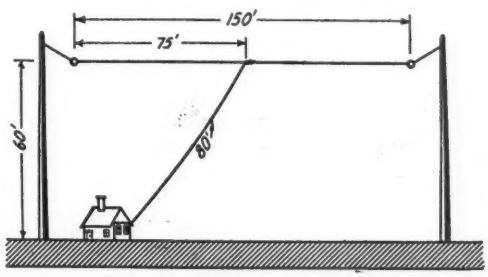
The Wavelengths of Antennas

By John Vincent

This is the first of a series of elementary educational articles on wireless subjects, which will be a feature of the Radio Section of the POPULAR SCIENCE MONTHLY *during the coming months. While designed primarily for beginners, the subjects will be handled so exhaustively that the series will be of interest to advanced amateurs and professionals as well.*—EDITOR.

MANY amateurs and professional operators are at a loss when they need to find the length of antenna necessary or most desirable to use for sending or receiving a given wavelength, or when they wish to calculate the natural wavelength of some specific antenna. The rules for such computations are very simple, so that once they are understood there should be little or no difficulty in solving either of these problems.

If a single wire is hung vertically from a mast and connected to one side of a spark gap, the other side of the gap being grounded as in Marconi's early arrangement, the plain aerial system so formed will radiate waves of approximately 4½ times its length. That is to say, if the gap is grounded directly and the aerial wire running from the spark gap to the top of the pole is 100′ long, the wave radiated will be about 450′ long. To get this wavelength in meters the number of feet must be divided by 3.28; 450′ thus is found to be 137 meters. This, then, is the fundamental wavelength of a vertical wire 100′ in length. To increase the wavelength which is to be sent out, it is necessary to add inductance in series with the aerial, or to increase its own length. However, when wire is added in coil form the wavelength is increased by much more than 4.5 times the length of the wire in the helix.



Total length, 155 feet; natural wavelength, 220 meters

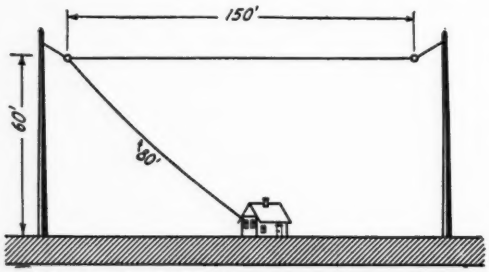
If the antenna wire runs for part of its length in an approximately horizontal position, and if the aerial consists of several wires in parallel, as is common in radio stations to-day, the length of the fundamental wave will be about 4.7 times the length of the aerial itself, because of the added capacity due to nearness to earth. Thus, if the spark gap, having one side grounded, has its other terminal connected to an aerial consisting of six parallel wires 150′ long strung between the tops of two poles 60′ high, with a lead-in wire 80′ in length from one end of the span, the total antenna length will be 80′ plus 150′, or 230′. This is equal to 70 meters (dividing by 3.28) and gives a fundamental wavelength for operation without series inductance of 330 meters (multiplying by 4.7). When the lead wires are connected to the center of the flat top antenna, thus making a "T" aerial instead of an "inverted L," the length is measured from the instruments, via the lead, to either end of the span. For the flat top just described, if the leads were taken from the center instead of from one end, the total length would be 80′ plus 75′, or 155′, or (dividing by 3.28) 47 meters. The fundamental wavelength, or that which would be radiated if the antenna were excited without inductance in series, would therefore be 220 meters.

The fundamental wavelength of an antenna is affected almost entirely by its length, and very little by the number of wires used in parallel. Whether you use two wires 6′ apart and 200′ long, or 8 wires 4′ apart and 200′ long, the fundamental wavelength will remain practically the same. However, with more wires stretched side by side the effective resistance of the conductors will be less and the ratio of antenna capacity to antenna inductance increased, so long as the wires are kept quite well separated. Not much is to be gained through the reduction in resistance, since the wire resistance is so small a part of the total resistance of the antenna-and-earth system. For working at wavelengths considerably above the fundamental, though, it is advantageous to build the aerial with many wires, i. e., of large capacity, for it can be then tuned to the longer waves with less loading inductance.

All of the above has to do with the fundamental wavelength of aerials. The actual operating wavelength nowadays is usually much greater than the fundamental, since inductance coils are added in series for the purpose of coupling to the closed circuit of

the transmitting station. The "plain aerial" arrangement, which sends out waves of the fundamental length, is not used at present on account of the high damping of its waves and the broad tuning which is thereby necessitated. Some few antennas are used with condensers in series, in addition to the coupling coil inductance, so as to operate on wavelengths very close to or below the fundamental, but this arrangement is not efficient. The usual plan provides for inductance in series, and the usual wavelength is therefore greater than the fundamental.

In order to calculate the operating wavelength of an antenna when a given inductance is placed in series with it, it is necessary to consider antenna capacity and antenna inductance. Every aerial has both these properties in varying amounts, and its natural or fundamental wavelength is determined by the product of its capacity and its inductance. The longer any antenna is, the more capacity and the more inductance it possesses, and therefore the longer is its natural or fundamental wavelength. The more parallel wires in any antenna the greater is its *capacity*, but the *less* is its inductance. These two quantities change in opposite and equal amounts as wires are added side by side, so that the fundamental wavelength remains about 4.7 times the actual antenna length, as explained above, for all ordinary aerials.



Total length 230 feet, natural wavelength 330 meters

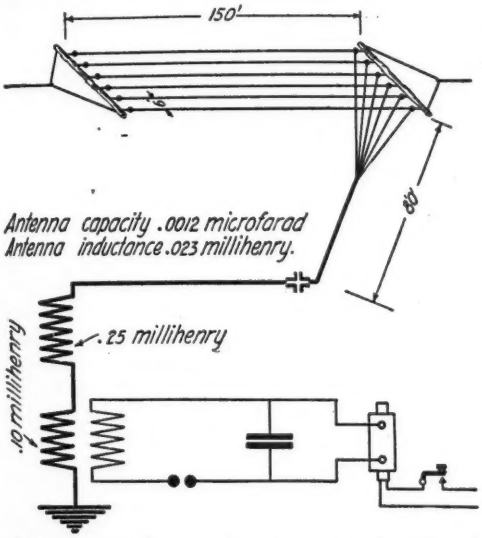
If we are able to find out the capacity and the inductance of any antenna we can calculate its natural wavelength at once. It is only necessary to multiply the number of microfarads capacity by the number of millihenrys inductance, take the square root of the resulting number and then multiply by 60,000. The answer is the natural or fundamental wavelength in meters. As an example, let us consider the flat top inverted L aerial described above, which has a total length of 230' or 70 meters. The capacity of this antenna is fairly large, since the wires are 6' apart, and measures 0.0012 microfarad. The inductance is 0.023 millihenry. Its fundamental wavelength, according to the rule just given, is found by (1) multiplying these two figures together, with the result 0.0000276, (2) taking the square root of this, with the result 0.00526, and (3) multiplying by 60,000, the final result being 316 meters. This is reasonably close agreement with the natural wavelength found by the simpler approximate rule of multiplying the antenna's length by 4.7, which was 330 meters. The more complicated method of calculating from the known inductance and capacity is the more reliable way.

This second rule is the one to use for finding the wavelength of operating antennas when a known amount of inductance is connected in series and the wavelength is therefore increased. It is necessary only to use the *total* inductance of the system, which is obtained by adding together all the inductances connected in series, in place of the antenna inductance alone. Consider the same flat top antenna having connected in series with it an oscillation transformer secondary of 1/10 millihenry inductance, and a loading coil of 25/100 millihenry. The total inductance is then 0.023 (antenna) plus 0.1 (secondary) plus 0.25 (load coil) or 0.373 millihenry. The capacity is unchanged, 0.0012 microfarad. The operating wavelength is found as before, by (1) multiplying the inductance by the capacity, with the result 0.0004476 or, since three figures besides the zeros are always enough, 0.000447, (2) taking the square root of this, with the result 0.0213, and (3) multiplying by 60,000, with the final result of 1,270 meters, the operating wavelength. Thus it is seen that placing coils to the amount of 0.35 millihenry in series with the antenna has increased its resonant wavelength from 316 to 1,270 meters.

The two ways of calculating wavelengths of aerials just explained are the only two really reliable methods for doing this. Any plan based upon the number of feet of wire coiled up in the transformer secondaries, or on anything except the quantities leading directly to the true inductance and capacity of the antenna itself, is likely to give very inaccurate results. The computations are at their best uncertain when used, before it is put up, to predetermine the kind of antenna desired. When an antenna has been built, however, and when its capacity and inductance are known, the second rule given above is quite dependable. Nevertheless, for accurate results, the best way to find the operating or natural wavelength of any existing antenna is to measure it with a wavemeter.

Very often it is desired to find out before erection just how large an antenna will be necessary for radiation of waves at some certain wavelength. This can be done quite eas-

ily by working backward the rule first given. Suppose one wishes to send on a wavelength of 200 meters, the longest permitted to amateurs by present radio regulations. Remembering that it is inefficient to operate the aerial at less than 1¼ times it natural wavelength, the longest permissible fundamental wavelength is found, by dividing 200 meters by 1.25, to be 160 meters. For this natural wavelength the antenna should be 160 meters divided by 4.7, or 34.5 meters in total length. Multiplying 34.5 meters by 3.28 gives 112', which is as long as the proposed aerial should be. For 200 meter sending, then, the antenna might well consist of 4 parallel wires, each pair 4' apart, slung between 40' poles 70'



Antenna system working on wavelength of 1270 meters

apart, with the lead taken from one end. To get greater capacity the "T" form might be used, in which case the poles could be 140' apart. Either of these antennas would have a natural wavelength below 160 meters, and the amount of inductance to place in series in order to reach 200 meters would be sufficient to give coupling with the closed circuit at the sender. The exact amount of inductance needed could be calculated by using the second rule backwards, if the antenna capacity and inductance were known. As a general thing, however, it is not possible to approximate these values closely enough to make the calculation of much value; it is best to wait till the antenna is finished and then to measure its capacity and fundamental wavelength. Knowing these, the amount of inductance needed for any wavelength may be computed easily, as has been shown. But the wavelength of 200 meters, may be reached very easily, even without knowledge of the exact antenna capacity and inductance, for having once built the antenna of suitable natural wavelength according to the method just explained, it is only necessary to add inductance a little at a time, measuring the wavelength at each step and stopping when that desired is attained.

It is always useful to remember that, regardless of the size or kind of wire, the number of wires, or their spacing or their height from the ground, the fundamental wavelength of any ordinary antenna is very nearly 4.7 times its actual length. The antenna length must be stated in meters if the wavelength is desired in meters; or in feet if the answer should be in feet. The total length of the aerial is the only factor that largely determines its natural wavelength.

Wireless Club—University of Missouri

This society was organized at the beginning of the school session, 1914-1915, at the University of Missouri, Columbia, Mo. At present the club has about 15 members. Meetings are held weekly and addresses made by members of the university faculty or papers read by members of the club.

The organization maintains a wireless station at the university for the use of its members. The antennae of this set is made up of 4 wires, stranded copper, 120' long, 90' high at one end, and 80' at the other. The sending set which has been installed consists of a ½ k.w. G. E. 10,000-volt testing transformer, oscillation transformer, rotary spark gap and condenser.

The receiving set consists of 2,000 ohm phones, Perikon, Galena, and Audion dectectors, loading coil, loose coupler and variable and fixed condensers.

With the above set, Key West, Arlington, Sayville, Illinois Watch Co., Gulf boats and many other stations have been heard.

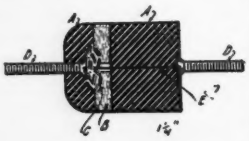
During the Easter holidays returns of the Willard-Johnson fight, personal messages, orders, etc., were sent from this station to the cadet encampment of the Missouri State Military School, which was held at Rocheport, Mo., on the Missouri River, 15 miles from Columbia.

The officers of the Wireless Club of the University of Missouri for the coming season are: Robert M. Walker, president; Clarence O'Daniel, vice-president; Vernon G. Cox, secretary and treasurer, and Elliot A. White, faculty advisor.

All communications should be addressed to the secretary, at Benton Hall, Columbia, Mo. The club would like to hear from nearby amateurs.

A Crystal Detector

The diagram shows how a detector which cannot lose its adjustment may be made. It may even be dropped on the floor without loss of sensitiveness. The cost of making is very small, since it requires only a brass or metal cap, a piece of silicon, two battery screws and some sealing wax. First drill a small hole in the bottom of the cap, just large enough for a battery screw to slide through. Next secure a piece of silicon having a flat surface, and bind small pieces of fine copper wire very tightly around each end of it. After doing this, bring the two ends of wire together and join them with the head of the battery screw at the bottom of the cup. Then pour hot sealing wax into the cup, bringing it even with the level of the silicon, being careful not to drop any on the crystal. Next place about eight layers of tissue paper on top of the silicon, and find a sensitive spot by punching a needle (which is to be connected to a test buzzer) through the paper. After locating the right spot, carefully remove the needle and insert a piece of copper wire in its place. Then pour in wax enough to fill the cup, and connect the wire with a battery screw at the top. This gives a fixed detector which will last some time before it loses its sensitiveness. Two which were made a month ago are working finely.



Care of the Station

To obtain the maximum efficiency from any wireless set one must use a little system. A few minutes' work every day will improve both the appearance and working range of your station.

The following station routine has been used for four years in one plant, and is found entirely satisfactory:

DAILY.

Wipe off all instruments with care.

Tighten all contacts.

Clean commutator of rotary gap motor.

WEEKLY.

Polish all metal work, key, switches, etc.

Rub down and polish instrument cases.

Examine all contacts from power source to antenna.

Vaseline movable contacts lightly.

Blow out armatures and fields of motors.

Wipe off glass of condensers and clean rack.

Clean and polish transmitting inductance.

Oil rotary gap motor.

MONTHLY.

Clean and tighten ground contact.

Clean key contacts and see that faces are parallel.

SEMI-ANNUALLY.

Lower antenna, clean off insulators, overhaul ropes and replace old and worn ropes with new.

Polish all hard rubber work with carbon bisulphide (this can be obtained from any drug store).

THINGS TO BE REMEMBERED.

Do not finger detector crystals, for by doing so you reduce their sensitiveness

To clean old and dirty crystals wash with carbon bisulphide, using a toothbrush; then wash with soap and water and finish by washing in clean water.

Receiving instruments should be as far from transmitting apparatus as practicable.

Long lead wires between instruments should be avoided as much as possible, for they cut down efficiency.

Keeping contact points bright cuts down resistance losses.

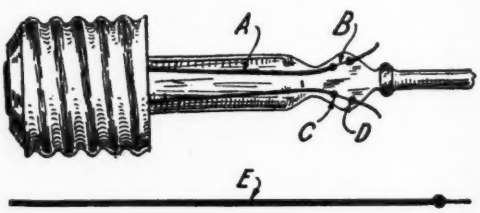
Short circuit detector while transmitting.

Keep the spark white and crackling. If there is an arc lengthen the gap. If the spark is stringy shorten the gap.

A micrometer gap made of two strips of brass on the aerial and ground binding posts will save your receiving outfit in time of lightning storms.

A Contact for Crystals

Take a 100-watt mazda lamp and break the glass bulb, being careful not to damage the glass stem inside; then lay the glass stem containing the copper lead-in wires *A* on a block of wood, and with very light blows, from a small hammer, break off all the glass. Be cautious not to injure the platinum wire *B* or the connection *C*. Next, cut off the platinum wire very close to *D*. This leaves, as shown in *E*, the copper wire with the platinum wire attached. The fine platinum wire does not discolor or tarnish and gives a good light contact with a crystal when used in a well built detector stand.



A wire-contact from an old lamp globe

Undamped Oscillation Systems of Radio Telegraphy

By A. J. Watts

(Continued from November)

IN point of simplicity of construction neither of the systems just described for the production of undamped oscillations can approach that of the Poulsen arc as developed by the Federal Telegraph Company. A simple diagram of the connections of this apparatus is given in Fig. 3, wherein the arc gap *C D* consists of two water-cooled electrodes which burn in a chamber supplied with a steady stream of hydrogen or ordinary illuminating gas. Two blow-out magnets, *E* and *D*, are connected in series to the source of energy through the arc and are placed at right angles to the arc points, tending to make the electrodes burn evenly, and also to produce a greater difference of potential between the arc terminals than would be possible without them. Inasmuch as the arc is connected directly in series with the antenna system the frequency of the emitted wave is governed by the inductance, capacity and resistance of the arc gap and the antenna system. Hence the emitted wave may be instantly changed by the mere insertion of a few turns of inductance in the antenna circuit. As a matter of fact, the commercial stations of the Federal Telegraph Company are fitted with a number of switches for immediate change of the emitted wave in order that long distance communication may be maintained during the periods that the reflection and refraction phenomenon of the upper atmosphere changes.

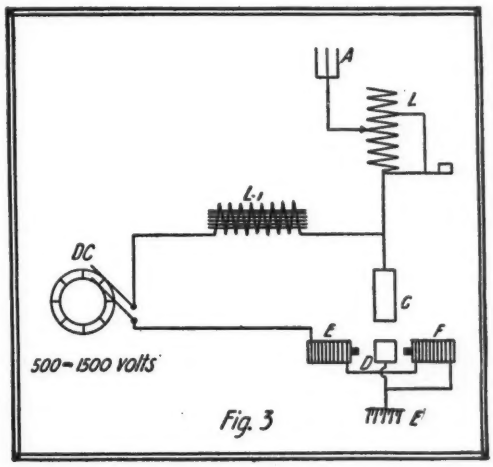


Fig. 3—Wiring of Poulsen arc sender

Thus it is found that often when a sudden depression in the strength of signals takes place between two long distance stations, proper selection of another wavelength will restore communication. The only disadvantage of the Poulsen arc system lies in the fact that the arc electrodes require considerable attention, such as cleaning, renewing, etc.

Transmitting apparatus of this type is employed at the large United States Navy stations at Arlington, Va., at Darien, Isthmus of Panama, and at Point Loma, San Diego, Cal. (The arc and spark apparatus are both used at Arlington.) These three stations are located about 2,500 miles apart and have carried on successful daylight communication.

"BEAT" RECEIVERS

For a number of months the amateur field has had an inkling of certain extremely long distance experiments performed by amateur and professional investigators, who, by means of a single audion detector, have taken down messages from high-power stations at distances from 3,000 to 6,000 miles; and while the circuits for this apparatus have passed from one to another in a quiet way, few have been really able to produce a workable equipment which could be relied upon. The details of the dimension of the various coils comprising such a receiving tuner have not been published, because the apparatus is not generally understood. Therefore, data for a tried and tested set may be of interest.

In the diagram Fig. 4 we have given the circuits of a receiving tuner which will allow the reception of signals to a distance of 3,000 miles in daylight when employed in connection with an audion of the proper characteristics. It may be mentioned at the start that the type of audion having a double plate and double grid is preferable for this work.

Referring to the diagram, the primary winding of the oscillation transformer L 2 is 8½" in length by 5½" in diameter, wound closely with No. 24 S. S. C. wire. Variation of the inductance value may be obtained by a multiple point switch or sliding contact, preferably the former.

The aerial tuning inductance L 1 is 28" in length by 5½" in diameter, wound closely with No. 20 S. S. C. wire. Taps may be brought from it at intervals of 1".

The secondary winding L 3 is 14" in length by 5" in diameter, wound closely with No. 28

S. S. C. wire. It also may be fitted with a multiple point switch, taps being taken up every ½". The secondary loading coil L 4 is 22" in length by 5½" in diameter and may have two or three tapoffs at the low potential end. The inductance coil of the telephone circuit L 5 is 27" in length by 5½" in diameter, wound closely with No. 28 S. S. C. wire.

The coils of the radio frequency transformer L 6 and L 7 are connected as shown and placed in variable inductive relation. These coils are of nearly like dimensions, viz.: L 6 is 5" in diameter by 7" in length, wound closely with No. 28 S. S. C. wire. L 7 is 5½" in diameter by 7" in length, wound with wire of the same size.

able functioning of the apparatus follows:

When a certain critical potential is applied to the local telephone circuit of the audion and the filament brought to a definite degree of incandescence, the local circuit of the audion becomes a generator of undamped oscillations, the frequency of which is determined by the condenser C 3, the inductance L 5, and the coupling coil L 7. Generally the entire coil of L 5 is in use, and the adjustments for frequency made at C 3 alone. By a suitable value of coupling between L 6 and L 7 the oscillations of radio frequency from the local circuit are amplified by the well-known trigger action of the audion. The secondary circuit and the local telephone circuit must therefore be tuned

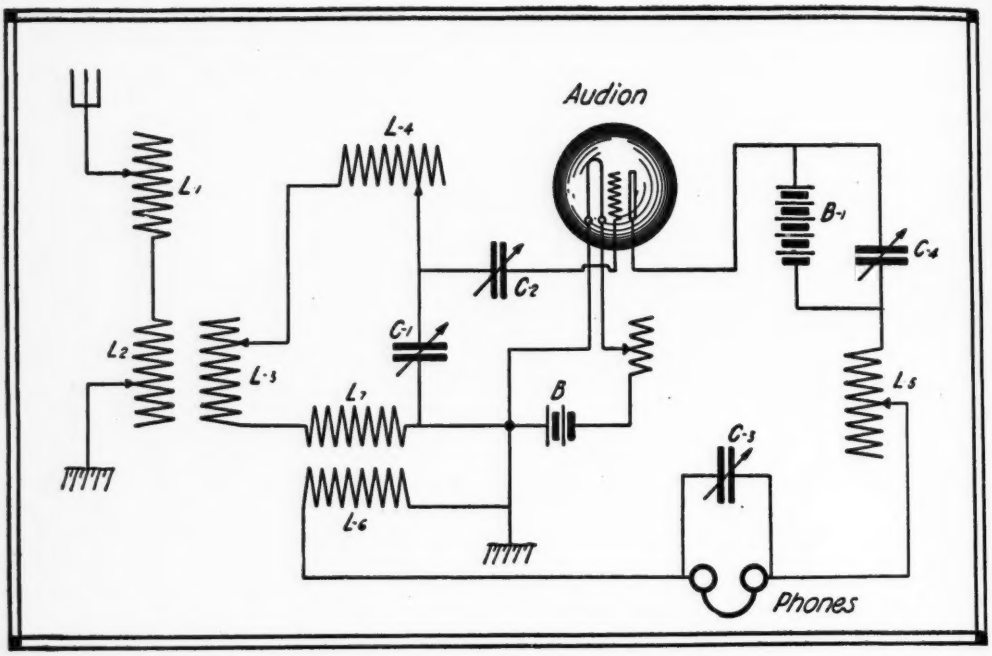


Fig. 4—Diagram of the Armstrong circuit

The variable condenser C 1 may have a maximum value of capacity of .001 Mfds. The maximum capacity of C 2 need not exceed .0002 Mfds. C 3 should have a value of .001 Mfds. and C 4 about .003 Mfds.

The filament battery B has a maximum potential value of 4 volts, while B 1 may have a maximum value of 60 volts. The rheostat R should be of 10 ohms resistance.

OPERATION

It is to be especially noted that the condenser C 2 is generally employed at exceedingly low values of capacity, not over .00001 Mfds.

Having connected the apparatus in accordance with the diagram of connections in Fig. 4, the procedure for adjustment and the probto resonance. It now only remains to tune the antenna system to the incoming wave and the secondary circuits to a slightly different frequency, thereby producing the well-known heterodyne or "beat" action, as first suggested by Fessenden.

The tuner described is only suitable for the reception of wavelengths between 6,500 and 10,000 meters, the over-all dimensions being too great for the shorter range of wavelengths.

For receiving signals from Tuckerton using the Goldschmidt alternator, an extremely pure musical note is obtained which may be varied from about 200 cycles to the limits of audibility by means of the variable elements of any of the circuits. The note obtained from the

Poulsen arc is not so pure on account of the irregularities of the arc itself, but an equally pure tone is possible from the Joly apparatus as used at Sayville.

In order to obtain satisfactory results, the adjustments of this apparatus must be extremely precise throughout, more so than with any other type of receiving apparatus. On this account if efficient results are not obtained it is due to ignorance on the part of the manipulator concerning the best working adjustments of the audion. A few trials, however, will familiarize the operator with the circuits.

The apparatus under consideration is so sensitive that the operator adjusting it to resonance must stand at a distance of at least 3′ from the secondary tuning coils and variable condensers, otherwise the associated circuits will be thrown out of resonance when the body of the adjuster is removed. To eliminate this effect the variable condensers should therefore be fitted with long handles, say 20″ in length.

When the local telephone circuit and the secondary circuit are out of resonance certain types of audions will produce a hissing or musical note, but when adjusted together the telephones are quiet.

It is positive proof that the audion is generating undamped oscillations if, when the capacity of the condenser C 4 is varied, a certain peculiar "thud" is heard in the telephone receivers.

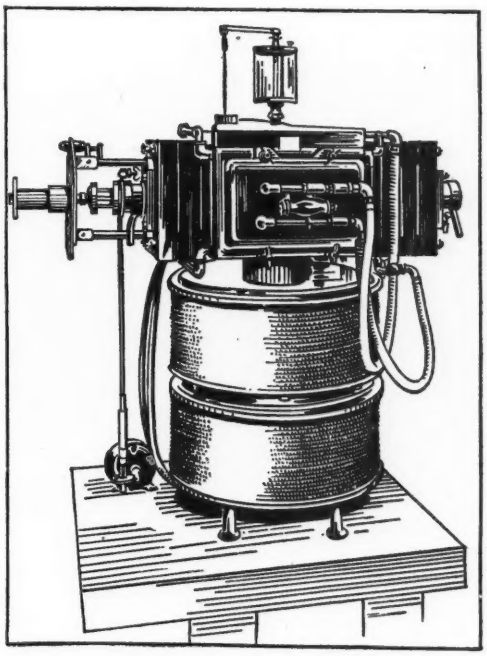


Fig. 5—Thirty K.W. Poulsen-Federal arc transmitter

HOW TO MAKE THE AUDION OSCILLATE

Certain audions require preliminary treatment before they become efficient and sensitive undamped detectors. A series of experiments have disclosed that the following characteristics are essential for efficiency:

(1). The audion should be one where the "blue glow" appears at a very low voltage in the telephone circuit—not over 25 volts.

(2). Many audions may be brought to this state by the application of a small blow torch to the bulb while the filament is burning and with at least 60 volts applied to the telephone circuit. Care should be taken not to crack the bulb.

(3). The most sensitive audions are those where the "blue glow" increases slightly with small increments of potential of the high potential battery. If the "blue glow" appears suddenly and is unstable—appearing and disappearing—the bulb will be erratic in action.

(4). When generating undamped oscillations the bulb should be used below the "blue glow" point.

(5). With certain audions, after the above treatment is applied, the filament need not be burned brighter than cherry red.

The foregoing apparatus, employed in connection with an aerial having a natural period of from 400 to 1,000 meters, will permit the reception of signals from Darien, Nauen, or Hanover, Germany, in daylight. After dark signals may be received on the Atlantic coast from the Federal Telegraph Company's station at Honolulu.

The apparatus is also most sensitive to spark stations within the wavelengths for which it is designed, but at the point of greatest intensity of signals the normal note of the damped wave is destroyed, the resultant note in the receiving apparatus being of a lower frequency. By a slight sacrifice of intensity of signals the normal note may be maintained with considerable amplification. In the latter case the reception of signals is not based on a true heterodyne or "beat" action. With proper adjustment of all circuits indicated in Fig. 4, amplifications of 1,000 to 2,000 times the strength of signals obtainable with the ordinary circuit will be produced.

RADIO CLUB AT ANN ARBOR

A radio club has been formed in Ann Arbor, Mich. The officers are Mr. Glover, Pres.; Mr. Bucholz, Vice-pres.; Mr. Overbeck, Treas.; and Mr. Hoffan, Sec. The club has the support of the Y. M. C. A. and access to its educational features of wireless, and is located at the University of Michigan.

Radio Club News

Policing the Air

A great many radio clubs are organized each year, but more than 80% of them are disbanded before the first officers have served their full terms, owing to lack of interest.

There is a most successful radio club in one of our large cities, and one of the most novel and creditable ideas ever introduced in radio club circles is in full swing there at the present time. The members call it "Policing the Air." Every night there is an operator on duty at his private station, with a log sheet in front of him and a call list within reach.

Should any amateur persistently interfere after having been requested to keep out, send false distress signals or violate any rule made by the committee on rules and regulations, or violate any law enacted by the United States Government, his offense is noted in the policeman's log book, which is turned over to the committee on rules and regulations at the next regular meeting of the club. The offender is then compelled to pay a cash fine or be suspended from club meetings, or both; and should his offenses become too numerous he is expelled. A different policeman is on duty each night in the week.

HOW TO ORGANIZE A RADIO CLUB

To organize a club three or four men should get together and fix upon time and place for a meeting. Then they should notify all nearby amateur and commercial operators, and those others interested in wireless telegraphy. A wireless set may sometimes be used to good advantage for announcing the meeting. A general message with all necessary information may be sent each of several consecutive nights. When the time set for the meeting has arrived an hour should be allowed, if possible, for conversation, and to allow all interested to assemble.

A temporary president should be appointed, and also a temporary recording secretary to note the proceedings. A president, vice-president, secretary, treasurer, chief operator and three radio policemen should then be nominated and voted for, and the meeting should be turned over to them.

Committees should then be appointed by the president to draw up a constitution and rules and regulations, and to fix penalties. This committee is expected to take the time between the first and second meeting for this purpose.

The duties of the usual officers are too well known to require detailed explanation, but those of "chief operator" and "radio policeman" may be as follows:

It is the duty of the chief operator to direct the use of all apparatus owned or controlled by the club. He shall assign certain days and hours of the week on which the different radio policemen shall maintain a steady, close watch on all amateur radio traffic.

It is the duty of the radio policemen to see that the rules and regulations of the rules committee and the laws of the United States concerning radio communication be observed. All offenses should be noted in the log sheets, which are to be turned over to the chief operator for presentation to the chairman of the committee on rules and regulations at each meeting for their approval and action.

It is recommended that a meeting be held once a week, and that the dues be sufficient to cover the rent of a hall or room. For a nominal sum a room may be rented by the month in some small office building, where the management will permit the club to erect an aerial and install a radio outfit. If the treasury is sufficiently large, keep the leading electrical and radio magazines on file.

Another way to keep interest at a high pitch is for the most experienced operators in the club to give inexperienced members from half an hour to an hour of instruction in wireless telegraphy before or after meeting hours. Additional information is found in the "Radio Communication Laws of the United States and the International Radio-telegraphic Convention," which may be obtained for 15 cents, and in the "Radio Service Bulletin," the annual subscription price of which is 25 cents. Both may be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Marconi Amateur Radio Association

The Amateur Marconi Radio Association started its season on September 4, at Troy, N. Y., after a vacation period of about two months. At the last meeting the following officers were elected for the ensuing year: Wendell W. King, president; W. LeMay, vice-president; Harold G. Connor, secretary; J. Vaughn, treasurer. Twenty-one members now constitute the club.

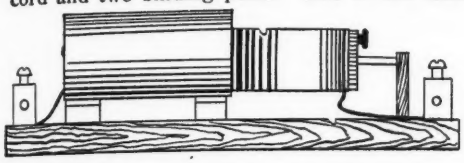
The Topeka Radio Club

The Topeka Radio Club was organized a year ago with a limited membership of twelve. The purpose of the club is to promote and regulate radio activities in and around Topeka, Kan. Six of the members have secured government radio licenses and the entire club will be composed of licensed members in a short time. The following are the officers: President, E. Broberg; vice-president, J. Keating; secretary and treasurer, W. Beasley; sergeant-at-arms, R. Morehouse. All communications should be addressed to the secretary, Wm. A. Beasley.

A Cheap Variable Condenser

A large number of amateurs are without variable condensers because of the trouble and expense of building one, or the high cost of a purchased one. These difficulties may be overcome by rigging up a tin-can condenser in the form of a loose coupler.

To make a variable condenser of this type procure two tin cans, a suitable base, a wooden rod, an insulated knob, 6″ of flexible cord and two binding posts. One of the cans



A condenser made from tin cans

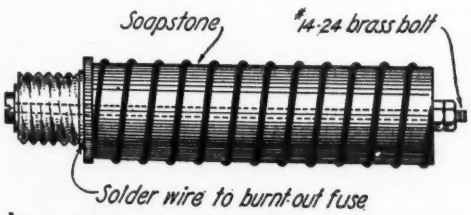
should be about 1″ larger in diameter, and about 2″ longer than the other. In the can having the largest diameter place about ¼″ of waxed paper or cardboard. This is to prevent the smaller can from touching the larger one when it is pushed all the way in. Next get a wooden rod ½″ in diameter and 1½″ longer than the sum of the lengths of the cans, also a small pillar. Bore holes in the exact center of the bottom and cover of the smaller can large enough to permit the can to slide freely. Make connections and assemble the condenser on its base.

A neater-looking condenser, but one which costs a little more, can be made in the same way by using lengths of brass tubing with turned wooden plugs at the ends.

Lamp Receptacle Resistance Unit

The resistance unit shown is designed to be used in place of a lamp resistance. Thus if a storage battery is to be charged a number of these resistances can take the place of the bank of lamps.

The unit is made from a burned-out fuse with a tube of porcelain or soapstone fast-



Lamp resistance made from a burned-out fuse

ened by means of a 10/24 threaded brass bolt with two nuts, one to hold the tube in place, and the other for the connection for the wire. The other end of the wire is soldered to the end of the threaded sleeve, and should be insulated from the knurled brass cap serving as a grip to screw the unit in.

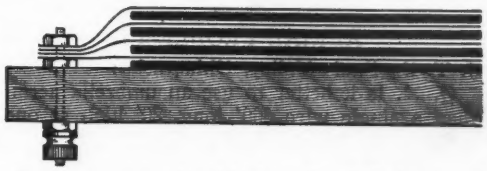
A number of these units will be convenient for the laboratory, and may be wound to resistances of 5, 10, 15, 20 and 25 ohms., etc. Any required resistance may thus be obtained.

An Aerial Hint

To experimenters using long single wire aerials the following may be of assistance: One often needs to know whether his aerial wire has stretched or in any way been lowered, for instance, by a passing storm, yet he does not wish to go to the lowest point to investigate. If the near end of the aerial is plucked, and the time is counted in seconds till the vibration returns, it may be compared with a similar reading previously taken at a time when the wire was fully stretched. As the time taken for the pulse to travel to the far end and return varies with the tension, the height of the aerial may be readily ascertained.

Terminal Connections for Condensers

Many amateurs are greatly troubled by the difficult and dirty method of soldering the foil-sheets of condensers together. A simple scheme shown in the drawing will be



A clean way of soldering the foil-sheets of condensers

of use to them. Secure a binding post and two pieces of brass about ½″ wide, ⅛″ thick and 1½″ long. Bore a hole in the center of both pieces of brass to fit the binding post and screw the binding post up tight.

How to Improve the Sound of a Buzzer

It may happen that wireless operators are troubled by the harsh and hoarse tone of the buzzer test. The difficulty may be quickly and cheaply remedied as follows:

Take a piece of match-stick about ⅜″ long and pry between the little piece of metal that is fastened onto the vibrator proper and on the vibrator. It will be found that the tone of the buzzer is very noticeably increased.

Plans for Radio Club in Boston

Amateurs in or near Boston who are interested in forming a wireless association with headquarters and central station, may inquire for particulars at The Young Men's Christian Union, 48 Boylston street, Boston.

What Radio Readers Want to Know

INDUCTION FROM POWER LINE

E. C. S., Deer Lodge, Mont., asks:

Q. 1. There is a 125,000-volt power line running 600′ from my wireless station. In my receivers I hear a high-pitched singing noise which I cannot tune out. I use a loose coupler and my aerial is at right angles to the power line. Is there anything I can do to shut out this noise?

A. 1. You are so near the power line and the voltage is so high that we do not believe that it would be possible for you to tune out the interference.

Q. 2. Would an interference preventer or a balanced tuner help?

A. 2. Yes, but you are so near the line that you will probably find great difficulty in tuning out the interference with any kind of tuner.

Q. 3. What is the right length of a 4-wire aerial 40′ high to be used with a 5″ spark coil?

A. 3. You will be limited by statute to 200 meters wavelength, which requires that the aerial and lead-in shall not exceed 85′ in total length, for good efficiency.

AERIAL PROBLEMS

J. T. B., Pauls Valley, Okla., asks:

Q. 1. Is it better to use an umbrella aerial than a single wire 300′ long, 20′ high at one end and 60′ at the other?

A. 1. If the umbrella aerial is at least 60′ high it will probably give the better satisfaction. It will be less directional than the single wire.

Q. 2. Will a long lead-in wire have any effect on the wavelength of a set?

A. 2. Yes; the wavelength will be increased by approximately 4½ times the length of the lead-in.

WAVELENGTH QUERIES

C. V. H., Kinsley, Kans., asks:

Q. 1. With a 1,500-meter loose coupler, a Blitzen duplex 2,500-meter loading coil, audion detector, 2,000 ohm head phones, 0.001 M.F. variable condenser and a 0.0165 M.F. fixed condenser, can I receive any wavelength in the United States? My aerial is one wire 600′ long, 75′ high at one end and 60′ at the other?

A. 1. No; but you can receive nearly any wavelength that you would probably desire to.

Q. 2. Can I receive damped and undamped waves with an audion detector?

A. 2. An audion can be made to oscillate and then act as a receptor for undamped waves. More variable condensers are required in the receptor for undamped waves. Unless you are familiar with radio work we do not believe you will have much success trying to use the audion in the oscillating state.

Q. 3. Would I get better results by using two wires in my aerial instead of the single wire?

A. 3. Yes, provided the wires were placed at least 8′ apart.

ASSIGNMENTS OF CALL LETTERS

S. H., Chicago, Ill., asks:

Q. 1. Please give me full information regarding the obtaining of a call letter for a receiving station.

A. 1. A receiving station does not require any license and accordingly would not have any call letter assigned to it. If you have a transmitting station you would be required to have an amateur station license. To obtain this license and the assignment of a call letter you are required to fill out two sets of blanks. The blanks for your application may be obtained by addressing United States Radio Inspector, Chicago, Ill.

BUZZ IN PHONES

R. H., Keyport, N. J., asks:

Q. 1. Several days ago I purchased a receiving set consisting of a tuning coil, fixed condenser, detector, and 1,000 ohm receivers. When I connected up the set I received a high buzz which sounds not unlike a spark, and which I cannot tune out. It remains in constantly morning and night, and I can pick it up with my receivers directly connected to aerial and ground. It is not the set, for I have tried it elsewhere with good results. Could it be a leak from the electric light circuits?

A. The buzz comes, undoubtedly, from some electric circuit. We do not know of anything you can do to get rid of it. The waves emitted are of such a highly damped character that they cannot be tuned out like an ordinary radio message.

CONDENSERS AND THEIR CAPACITY

A. R. H., Rapid City, So. Dak., asks:

Q. 1. What capacity condensers should be used in connection with a Packard 2 k. w. transformer and an aerial 200′ long and 70′ high?

A. 1. The amount of condenser which you could use would depend on the wavelength used. To get the full output from the transformer you would probably be able to use a condenser of about 0.08 M. F.

Q. 2. How large an oscillation transformer would be required?

A. 2. Wind the coils on a frame about 10" in diameter and put 5 turns on the primary and 15 on the secondary.

RADIO FREQUENCY CHANGERS

W. H. H., Cold Spring, N. J., asks:

Q. 1. Will you kindly give me a more complete description of the transformer which doubles the frequency of the current imposed on the primary winding, which you mention in the article entitled "Long Distance Wireless Telegraphy" in the August issue of the WORLD'S ADVANCE?

A. 1. It would be far too long an article to give in this column, but you will find one of the most complete short descriptions of radio frequency changers in print in the March, 1915, Volume 3, No. 1 issue of the Proceedings of The Institute of Radio Engineers. This is a 35-page article and covers not only static but dynamic, electrostatic as well as electromagnetic, frequency changers. It is fully illustrated and contains many graphs showing the relations of the several currents during the frequency changes. If you are at all interested in the subject, we most certainly recommend that you read this article. If you cannot obtain a copy of this publication from a library or member of the Institute you can purchase a copy for $1 direct from the Institute Secretary, 111 Broadway, New York.

Q. 2. To what degree is the core of the transformer saturated by the direct current?

A. 2. The core is saturated to the point known as the knee of the curve. It is the point where the saturation begins to increase very slowly with increase of magnetizing current.

FOR POULSEN MESSAGES

C. N. W., Bradford, Pa., asks:

Q. 1. Where can I obtain data for the construction of a ticker detector to receive messages from the Poulsen stations?

A. 1. A description of the ticker detector, together with construction details, will be found on page 353 of the December, 1913, Electrician & Mechanic. The oscillating audion is now being used to receive messages from stations using an undamped wave.

Q. 2. Is it considered the best practise to have the windings of receiving transformers and oscillation transformers go in the same direction?

A. 2. It makes little difference.

Q. 3. Should the winding of a pancake transformer commence with the outside or inside?

A. 3. It makes no difference.

Q. 4. Employing a 3-step amplifier and other correctly designed receiving apparatus will an aerial of the inverted L type, 2,000' long, average height 80', 4 wires, 6' spacing between wires, permit the reception of signals from the high power European stations?

A. 4. Yes.

Q. 5. Will city water pipes and gas pipes used in combination make a satisfactory ground for receiving?

A. 5. Yes.

CONDENSER CAPACITY

S. W. H., Williamsport, Pa., asks:

Q. 1. Please give me the capacity of the following condenser: Tinfoil, 8 sheets 6"x1"; dielectric, 9 sheets waxed paper 6"x1½"?

A. 1. 0.003 M. F., approximately.

AMPLIFYING SIGNALS

H. M. R., Jasper, Mo., asks:

Q. 1. Why is it that when I put a graphophone horn on the receiver to my radio set I do not get a loud sound, the same as from a graphophone?

A. 2. The signals are not loud enough to be heard in the horn. In a graphophone the horn is not the whole story. The important piece is the sounding box. If you place the needle that bears on the record against the receiver diaphragm you will probably be able to get a sound in the horn. The incoming signals, however, must be strong enough to move the diaphragm under the pressure from the needle. Also you can use only a graphophone whose action depends on up and down movements of the needle. Many, the Victor, for example, use a lateral motion of the needle, which, of course, bars that type from radio work. In general graphophones have not been very successfully used in radio work for increasing the strength of signals.

LOOSE COUPLER

W. M. K., Windsor, Ont., asks:

Q. 1. Please give me the dimensions of a loose coupler which will receive wavelengths of 1,500 meters.

A. 1. The coils should be made up of 150 turns of No. 28 B. & S. gauge copper wire, wound on cylinders 5" long. The primary should be on a 5¼" in diameter cylinder and the secondary on a 4¾" in diameter cylinder. About 225 feet of wire will be required for each coil.

Q. 2. What are the dimensions of a double slide tuner to receive wavelengths up to 1,500 meters.

A. 2. Use the primary coil mentioned in question 1.

Q. 3. Could I also use the coil mentioned in question 2 as a single slide tuner and still receive wavelengths up to 1,500 meters?

A. 3. Yes.

SPARK GAPS

H. E. G., Rockland, Mass., asks:

Q. 1. Will a quenched gap work in series with a rotary gap?

A. 1. Quenched gaps have been used with good results in series with rotary gaps. A rotary gap is usually a quenched gap in itself.

Q. 2. Does this combination increase the pitch of the spark?

A. 2. Such a combination would have very little effect on the tone of the spark. Increase the speed of the rotary gap to increase the pitch of the spark.

Q. 3. How many discs will I have to use on a 13,200-volt transformer spark?

A. 3. This will depend on the rotary gap. The combination of the two gaps is very much an experimental one, and about all we can tell you is to make a gap with 4 or 5 discs and try it out until you get the best result.

Q. 4. Will a rotary quenched gap give a shrill whistling spark?

A. 4. Yes; if properly designed.

Q. 5. Do ships use a rotary quenched gap?

A. 5. Most of them do. They also use a 240, or even a 500-cycle generator to get the tone they have.

Q. 6. Is the safety gap of a transformer connected across the secondary?

A. 6. Yes, thereby making it in multiple with the leads going to the other transmitting instruments.

MAGNETIC DETECTORS

S. S., Stamford, Conn., asks:

Q. 1. Is the secondary of a ½" spark coil suitable for the secondary of a magnetic detector?

A. 1. We are not familiar with any form of magnetic detector which employs a secondary similar to the coil you mention.

Q. 2. Where can I get information which will describe the various types of magnetic detectors? Could you give me this information in the Questions and Answers Column?

A. 2. No; it would be entirely too long to give here. Section 9, Chapter VI, of the second edition of "The Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming, is devoted to this subject and covers the matter quite fully, both in regard to theory and construction details.

Q. 3. Is a magnetic detector easy to construct and operate? Is it very sensitive as compared with crystal detectors?

A. 3. The magnetic detector works fairly well on long wavelengths, but is not very sensitive on short wavelengths. In its commercial form it is very simple to operate, but the usual magnetic detectors of amateur construction are far from satisfactory. We greatly doubt if you would be repaid for making one.

ARC LIGHT INTERFERENCE

R. A. B., Columbus, Ga., asks:

Q. 1. Does an arc light if close enough to a receiving set have any effect on it? From 7.00 P. M. until 4.00 A. M. while the arc light is burning, which is located about 50 feet from my house, I can hear a hum which nearly downs out all messages.

A. 1. It is quite probable that the arc light is what is causing the interference. If there is a ground on the arc circuit this hum will be very disagreeable. The overhead wires make a very fine aerial for the system to radiate waves from.

Q. 2. How can this effect be avoided?

A. 2. It is practically impossible to avoid it. It can be relieved somewhat by placing your aerial at right angles to the arc light wires and by using a very loose coupling. You have our greatest sympathies for your misery, for misery it is. If any amateur has successfully found a way to overcome this trouble we would like to hear from him.

AERIAL TROUBLE

F. J. E. S., Wilkes-Barre, Pa., asks:

Q. 1. My receiving instruments are 38 feet from the ground and my aerial is 40 feet higher. Of late my receiving instruments have been working poorly. Do you suppose this is caused by the erection of a 16-story building about 300 feet from my station? My aerial is flat top and but 20 feet long.

A. 1. It is entirely probable that since your aerial is but 20 feet long and that a 16-story building contains a large mass of steel that it is shielding your station. It would be well to determine if your detector has not deteriorated. Also look around for a loose connection.

Q. 2. Would I gain anything by moving my set up three stories?

A. 2. Probably very little.

TUNING COIL WINDINGS

R. A. de V., Atlanta, Ga., asks:

Q. 1. With an aerial whose wavelength is approximately 600 meters what is the size and number of turns of bare wire I can wind on a coil 3" in diameter to get the greatest possible wavelength without using a loading coil?

A. 1. For all practical purposes the limit comes with the size coil you can find room for rather than the maximum wavelength. There is, to be sure, a wavelength above which your aerial would be too small to respond, but that wavelength would probably be somewhere in the order of 10,000 meters, so that you need have no fear of any tuner of reasonable dimensions being too large for the aerial. Wind the coil with No. 22 bare wire and by making the coil about 18 inches long you should receive 3,000 to 4,000 meters without using a loading coil.

Q. 2. How long a wavelength could I receive with a suitable loading coil?

A. 2. You would probably be certain of getting as high as 10,000 meters.

Reviews of New Radio Books

THE BOOK OF WIRELESS. By A. F. Collins. D. Appleton & Co., New York, 1915. 222 + xv. pp., 219 illus. $1.00.

This treatise on the elements of radio telegraphy will be of interest to beginners in wireless work. The author's intention is to provide sufficiently clear diagrams and descriptive matter to permit the veriest amateur to build, install and operate a successful "wireless" station; in this he seems to have been successful. The apparatus illustrated and discussed is all of well tested types and may be depended upon for reasonably good operation when properly manipulated.

The book is divided into three parts, the first five chapters concerning a small wireless outfit, the next four covering a long-distance wireless set and the remaining three being devoted to the induction coil, transformer and electrolytic interrupter. Chapter IV on "Learning the Morse Code" is of particular value to the novice in radio work. A dictionary of technical words and phrases is included as an appendix.

The paragraphs on adjusting the tuned transmitter and receiver and on the use of a hot wire ammeter are entirely too brief and sketchy to be of much use to the amateur who has faithfully followed the constructional directions and thereafter attempts to make his set work. This should be remedied in future editions; in the meantime the student will find much else of help to him in the present volume.

* *

EXAMPLES IN ALTERNATING CURRENTS, VOL. I. By F. E. Austin. Published by the Author, Hanover, N. H., 1915. 223 pp., illus. by diagrams.

A book of numerical problems in applied alternating currents, the answers and the methods of solution being fully stated. The first 41 pages contain an outline of mathematical processes from geometry and trigonometry through differentiation and integration, and will be found to be an excellent basis for review or reference. The generation of alternating e.m.f.'s is then taken up, and the text proceeds to explain various computations for both sine and non-sine waves. Inductance, power factor, inductive impedance, parallel circuits, capacity, resonant current values, and current-voltage relations in complex networks are then discussed. An appendix of tables and an index are included. As a whole the book seems reasonably accurate. Radio engineers will find the work useful. It must be borne in mind, however, that the author has not considered the radio point of view in all cases, as when on page 201 he says: "It is evident that at least two undesirable features attend the condition of resonance: excessive pressure or excessive current."

* *

THE YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1915. Compiled by The Wireless Press, Ltd., published by The Marconi Publishing Corporation, New York, 1915. 802 pp., 37 illus., and map. $1.50.

The third issue of this almost encyclopaedic annual is some 40 pages larger than the edition for 1914, although by the use of thinner paper the bulk has been somewhat reduced. The book is alone in its field, and is the only collection of material in which one may find the laws and regulations governing radio telegraphy throughout the world. To print even the complete table of contents would require much space; it should be noted, however, that the London Radio-telegraphic and Safety of Life at Sea Conventions are given fully. Over 200 pages are devoted to four lists of the radio stations throughout the world, and a five-language technical glossary, a dictionary, and collections of standard formulae and tables cover nearly 100 more. Eight new articles are contributed and are of interest from engineering and military viewpoints. The Marconi company of England is to be congratulated upon the production of a Year Book so useful as this, which, though naturally not entirely unbiased in treatment of work done outside the Marconi organization, should be in the hands of every person interested in the international scope of radio-telegraphy.

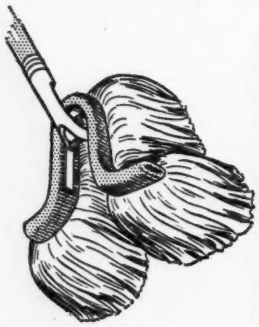
* *

OPERATORS' WIRELESS TELEGRAPH AND TELEPHONE HANDBOOK. By Victor H. Laughter. Frederick J. Drake & Co., Chicago, 1909. 180 pages, many illus. Price, $1.50.

The author prepared this book with the intention of providing a volume to guide the progress of students taking up the problems of wireless telegraphy with the aim of becoming expert operators. It was therefore necessary for him to follow a course midway between the highly technical and the feebly elementary treatments adopted by some other writers on the subject. The first two of the ten chapters take up the elements of electricity, but the remainder of the book is devoted to practical discussions of the various American arrangements of wireless apparatus which have so long been called "systems." Both wireless telegraphy and wireless telephony are described, and in the main the book should prove interesting to the group of readers for which it was intended.

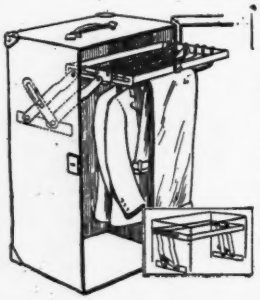
What's New in Patents

Dust Mop Cleans Corners



A NEW dust and polish mop has been found useful because of its ability to clean corners and crevices and behind furniture. The main feature of this mop is the two arms which project out, one on each side. One or other of these arms may be pushed into a small place which could not be reached by the usual round or oval mop.

Handy Portable Wardrobe

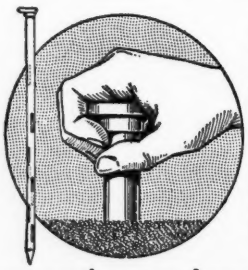


TWO pairs of parallel arms are pivoted on the inside of a suitable frame and their upper ends are tilted inward. Pivoted to these upper ends is a horizontal frame. When in use, the arms are tilted outward and the horizontal frame is extended to its utmost, making a sizable rack for suspending wardrobe hangers. This device is suitable for a wardrobe trunk, or for closets where the space is limited.

A Dancing Shoe for Fox Trotters

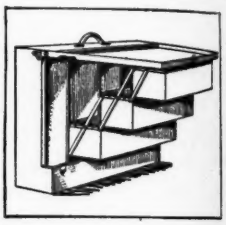
AN attachment for the soles of shoes to prevent slipping is made by cementing a thin disk of rubber to the shoe. A larger disk fabric with its central portion cut out to expose the major portion of the rubber disk is fastened securely over the edges of the rubber disk to the sole of the shoe, forming a protection which keeps the rubber disk securely in place.

A Device for Sampling Grain



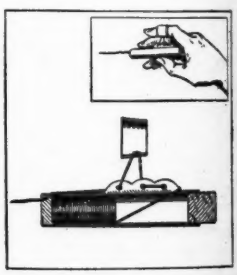
A GRAIN trier or tester to enable inspectors to obtain samples easily from various parts of a loaded grain car is made in the shape of a long, hollow pole. A number of ports or openings are formed in the side of the pole for the purpose of admitting grain at different points. These ports are opened and closed by means of a valve, the controlling device of which is in the handle of the pole. When the valves are opened, the grain flows into the hollow pole, and upon closing the valve, is kept there so that it cannot mix with the grain held in other sections of the device.

Autoist's Lunch Box



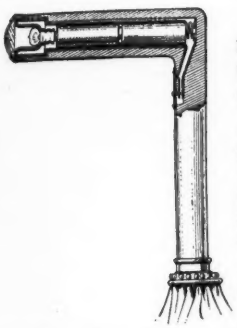
A COMBINATION luncheon case and table is made in the form of a suitcase, so that it may be easily strapped to the back of an automobile. When the cover is lifted a set of boxes is brought into position convenient for handling, and by means of a catch the cover is fixed in a position suitable for a table top.

Thread Holder Fits Finger



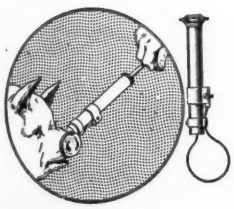
AN improved thread holder, especially adapted for use by leather workers in shoe or harness work is provided with a ring so that it may be conveniently placed upon the finger of the worker. It is also provided with a tension device for feeding out the thread from an enclosed spool to a needle or some other instrument.

Light in Cane's Handle



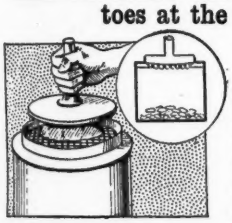
THIS device consists of a flash light built in the handle of an umbrella or a cane. A cylindrical battery and a bulb, with reflector and lens are contained in the handle, and the switch is in shank. The device should be of use in judging key holes at night.

Catching and Holding Hogs



AN invention embodying a device whereby hogs may be caught and securely held while ringing them is made somewhat in the form of a bicycle pump. On the outside of the tube a cord is fastened. The other end of the cord forms a loop and is fastened to the end of a rod which extends through the tube. To the other end of the rod is affixed a handle. The loop is caught over the ear or snout of a hog or other animal and the rod is pulled back. This causes the loop to be drawn tightly around the snout of the hog.

This Invention Slices and Peels Potatoes at the Same Time

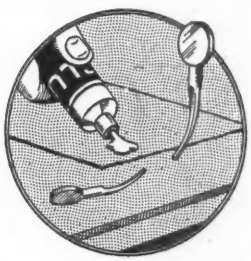


A COARSE metal screen is held in a disk which is placed over the top of a proper receptacle. The device is equipped with a plunger, which pushes the potato on the screen. In operation, the potato is boiled in order to toughen the skin and halved. It is then placed upon the screen, fleshy side down. The fleshy portion of the potato is forced down through the mesh, with the result that the mesh cuts the flesh into slices. The skin remains on the top of the screen, from which it may be easily removed.

Chilling the Ardor of the Setting Hen

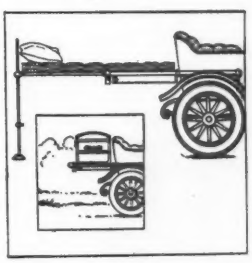
A VERY serious problem is often presented to poultry raisers by hens who are anxious to set on, rather than lay eggs. Porcelain eggs waste too much of the hens' time. The device in the illustration employs the old porcelain eggs; but they are so connected with a tank of cold water which is made to flow through them in a slow stream that the hen's enthusiasm is quickly cooled. At once the hen realizes that its heat is useless for warming the eggs; she leaves the nest and becomes a normal egg-layer practically cured of the desire to set. The flow of water is regulated by means of a small valve.

Plug for Glue and Paste Tubes



A STOPPER is made for glue and paste tubes with a curved blade for spreading the adhesive material over the desired surface. The handle is so weighted that when the spreader is laid upon a table the spreader projects upward and does not smear the table with glue.

Automobile Folding Bed



A COMBINATION automobile bed and baggage holder consists of pipes so arranged as to form an extensible frame. This frame is fastened to the rear of an automobile and, when extended for use as a bed holder, has two legs which are dropped to support part of the weight. It is claimed to be equally convenient as a baggage holder. The frame is contracted, and a hinged portion folds up to hold the baggage in place.

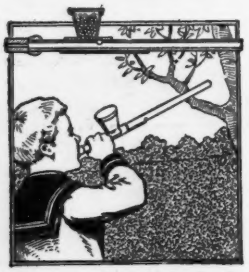
Blinds To Teach the Touch System of Typewriting

AN eye shield for use in teaching students the touch system of typewriting is made to fit the face below the eyes and entirely to obstruct the line of downward vision between the eyes and hands of the wearer. The shield itself is adjustable to suit the user. It is composed of two equal parts, joined by a system of slots.

A Shaving Brush with a Drip Cup

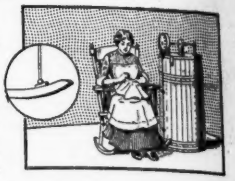
THE annoyance of dripping water has been abolished for the shaver by a new lather brush which has recently been placed on the market. The additional device which is attached to the brush is a rubber cup, placed at the bristle base in such a position that all water running from the brush is caught. As a result it is possible to shave without getting the fingers soapy and wet.

A Toy Blow Gun with a Magazine



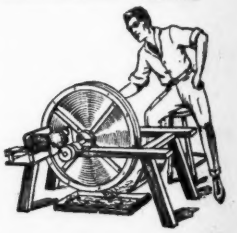
A TOY blow gun, to which is attached a magazine holding a quantity of small shot or other ammunition, is made so that shots may be rapidly fed into the barrel. A hole is made in the top of the barrel and another in the bottom of the magazine. When the magazine is slid forward in a groove so that the two holes correspond, a shot is dropped back, the hole is sealed and the gun is ready for the discharge.

Rock and Churn Butter



THIS device permits the operation of a churn by means of a shaft connected to the rocker of an ordinary rocking chair. The motion of the chair, by means of the connecting rod, imparts successive thrusts to the studs in a wheel at the top of the churn, thus making the wheel turn slowly at each thrust. This movement results in reciprocating the dasher in the churn through the agency of an eccentric disk and strap connections between the dasher shaft and the power shaft, upon which is located the studded wheel.

A Mechanical Sauerkraut Cutter



TO sauerkraut makers, the vegetable cutter shown in the illustration will have a decided interest. Essentially, it consists of four steel knives mounted at right angles upon a wooden revolving frame. The cabbage or any other vegetable to be cut is placed in the feeding-box. With slight pressure from the hand of the operator, the cutting is rapidly completed.

Feeding Nails Automatically

A NAIL holder or container which automatically feeds the nails into a slot, in a vertical position, ready to be conveniently and quickly withdrawn for use, is made with a breast plate and hooks, so that it may be strapped to the body. The nails are fed loosely into the hopper, and are held ready for the artisan by means of the groove, or slot. As the nails are withdrawn from the slot, a vibratory spout rebounds and releases another nail from the container to take the place of that which has been just removed from the slot.

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POPULAR SCIENCE MONTHLY
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Volume 87 Waldemar Kaempffert, Editor No. 6

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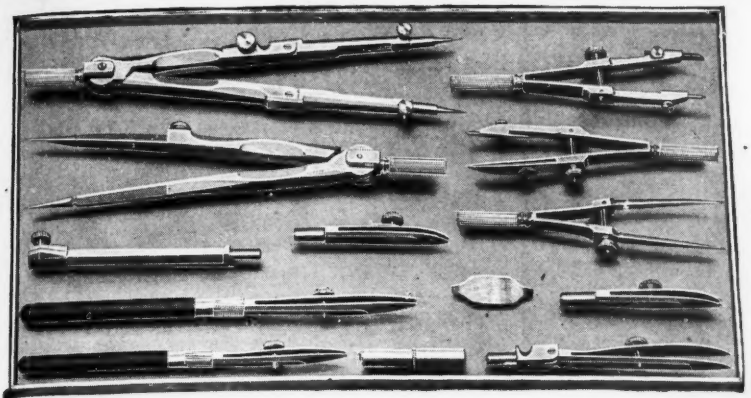

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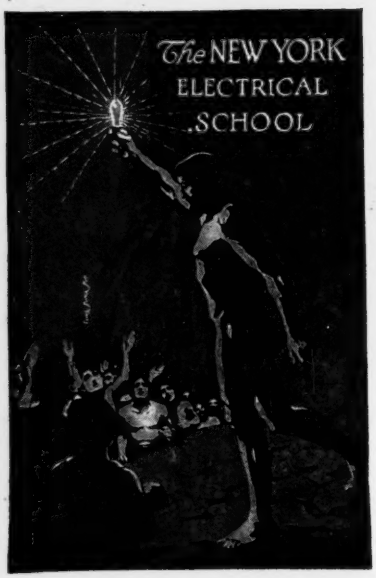

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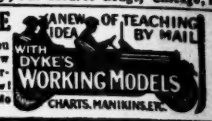

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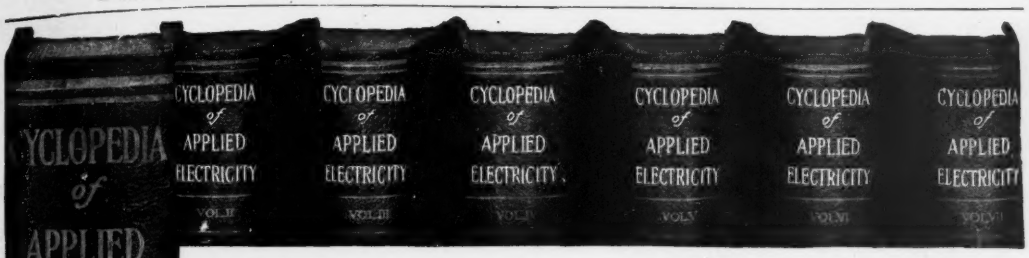

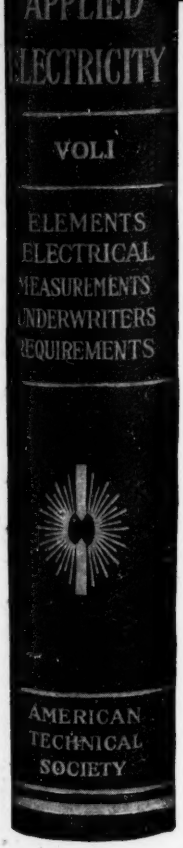

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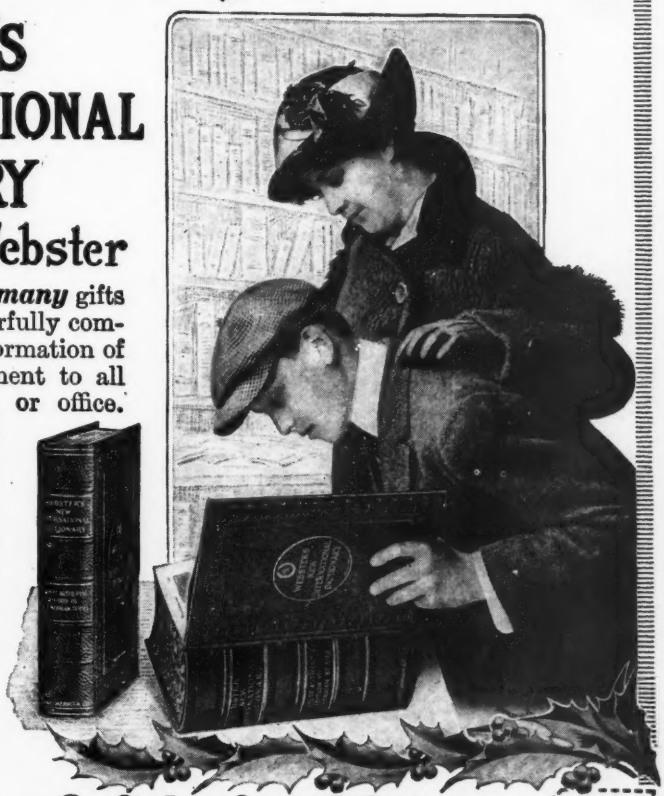

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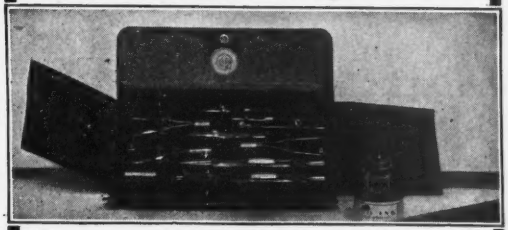

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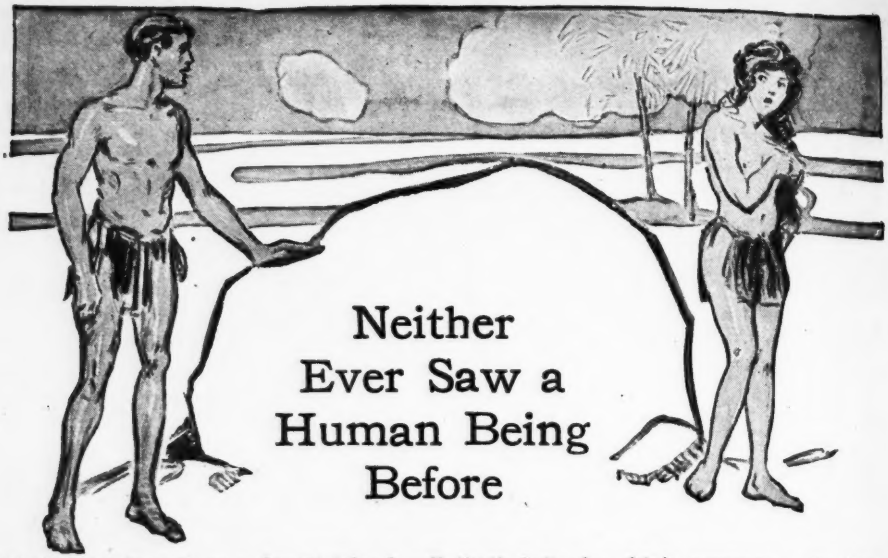

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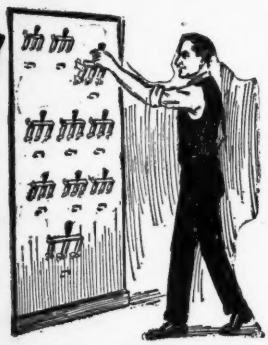

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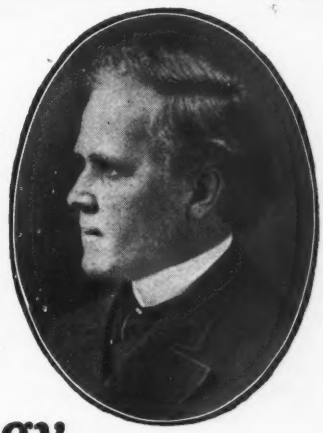

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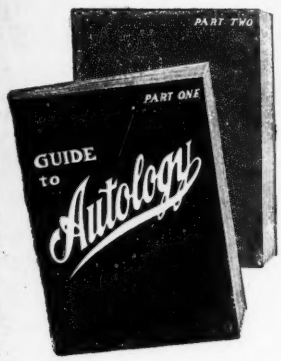

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Dr. Moras is a graduate of Harvard University Medical School, '88; College of Physicians and Surgeons (Chicago) '89; Formerly House Physician and Surgeon in Cook County Hospital (Chicago); Professor of Obstetrics, College of Physicians and Surgeons (Chicago).

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Tone perfection depends fully as much upon the scientific exactness of the reproducing mechanism of the instrument itself as upon the original recording process. The perfected reproducer and tone-arm of the Columbia Grafonola is the crowning achievement in this branch of the art.

Once you realize the tone possibilities of the Columbia Grafonola, playing Columbia Records or any other records, we believe you will never again be satisfied with any tone less full and true, less brilliant and round and natural.

Tone control:

With the Columbia you have every possible gradation of tone at your command. The tone-control leaves, built on the one right principle of controlling tone-volume, and the wide variety of needles available, give you any and all degrees of tone-volume, from the lightest pianissimo to the resounding fortissimo to fill the largest auditorium.

Convenience:

Your Grafonola, equipped with the individual record ejectors, an exclusive Columbia feature, is ideal in its convenience. Your records are racked individually in velvet-lined slots that automatically clean them and protect them against breaking and scratching. A numbered push-button controls each record—a push of the button brings any record forward to be taken between the thumb and fingers.

This model Grafonola with individual Record Ejector, $110. Prices in Canada plus duty.

COLUMBIA
GRAPHOPHONE COMPANY
Box L493, Woolworth Bldg., N.Y.

COLUMBIA

THE Bausch and Lomb BALOPTICON

Pictures sharp and brilliant to the corners—not dull and hazy.
Note the possibilities of the flat object holder.
Type like this—not like this

The pleasure and instruction which the ear gets from the talking machine, the eye gets from pictures and other objects shown by the

HOME BALOPTICON

made primarily as a projector of post cards, photographs, and various objects.

Special *400-watt, gas-filled Mazda lamp* with optically corrected mirror gives an illumination superior to anything heretofore offered, attaching to ordinary lamp socket.

Automatic, perfectly safe and simple enough for any child to operate. Fitted with high-grade achromatic lens, giving well-defined pictures sharp to the corners. Ideal equipment for clubs and small classrooms, as well as the home—not a toy.

Price for Home Balopticon complete for the projection of post cards, including aluminum coated screen, only **$35.** Sold by optical and photographic supply dealers.

Other models to meet any requirement, **$20** and up.

Write for our booklet "Fun—and better"

Bausch & Lomb Optical Co.
535 ST. PAUL STREET ROCHESTER, N.Y.

The Durham-Duplex Domino Razor with white American ivory handle, safety guard, stropping attachment, package of six of the famous Durham-Duplex double-edged, hollow ground blades in genuine red leather folding kit.

SOLVES YOUR CHRISTMAS PROBLEM

$5 DURHAM-DUPLEX Domino RAZOR FOR $1

We are requesting the owners of Durham-Duplex Demonstrator Razors to pass them along to friends, or at least to tell their friends about the shave it is possible to obtain with the wonderful Durham-Duplex Blade. This is good advertising for us, and we are paying for it by giving Demonstrator users an opportunity to obtain a Domino Razor for $1.00, with twenty United Profit Sharing Coupons.

DURHAM-DUPLEX RAZOR CO., Jersey City, N. J.

Gentlemen:—Send me a $5 Durham-Duplex Domino Kit Outfit as per illustration above for which find enclosed $1.00.

Name .....

Street .....

City..... State.....

Any dealer will honor this coupon T-12

A really sensible gift for a man

This Searchlight Shaving Mirror with its strong, steady, generous flood of bright electric light is just the gift a man will be certain to appreciate. Concentrates the light below the eyes—on the face and neck where it is needed most; no glare in eyes or mirror. Makes shaving easy. Useful on the dressing table, too.

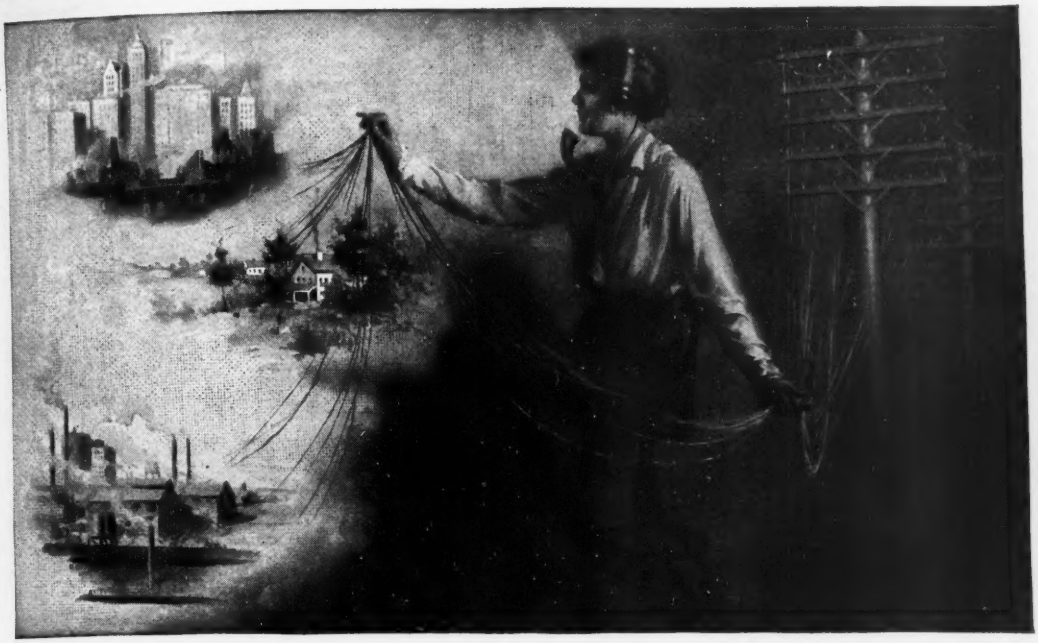
SEARCHLIGHT Shaving Mirror

Combination mirror and electric lamp with adjustable reflector shade. Big, solid, French bevel plate mirror, 8 x 10 inches. Strong, handsomely nickel-plated frame. Stands or hangs at any angle. May be used anywhere, home or traveling.

Order Today By Mail Just send $3.50 and we will ship this Searchlight Shaving Mirror complete at once, all charges paid, to any address you name. Mirror comes ready to use, handsomely packed in an attractive gift box. If you wish, enclose your gift card, when ordering.

$3.50 Complete Prepaid

FEDERAL SIGN SYSTEM (ELECTRIC)
Lake and Desplaines Sts., Chicago, Illinois



Weavers of Speech

Upon the magic looms of the Bell System, tens of millions of telephone messages are daily woven into a marvelous fabric, representing the countless activities of a busy people.

Day and night, invisible hands shift the shuttles to and fro, weaving the thoughts of men and women into a pattern which, if it could be seen as a tapestry, would tell a dramatic story of our business and social life.

In its warp and woof would mingle success and failure, triumph and tragedy, joy and sorrow, sentiment and shop-talk, heart emotions and million-dollar deals.

The weavers are the 70,000 Bell operators. Out of sight of the subscribers, these weavers of speech sit silently at the switchboards, swiftly and skillfully interlacing the cords which guide the human voice over the country in all directions.

Whether a man wants his neighbor in town, or some one in a far-away state; whether the calls come one or ten a minute, the work of the operators is ever the same—making direct, instant communication everywhere possible.

This is Bell Service. Not only is it necessary to provide the facilities for the weaving of speech, but these facilities must be vitalized with the skill and intelligence which, in the Bell System, have made Universal Service the privilege of the millions.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*

Trains Struktiron

Ives Toys

Make Happy Boys

His Christmas Question Answered

For weeks he has been hoping that his Christmas presents would include Ives Toys. And, of course, his dream is going to come true!

Watch how he "bubbles over" with happiness on Christmas morning when he sees his Ives Train and Ives Struktiron. They're gifts that enthuse any youngster.

Boys—with an Ives Railway you lay the track; arrange the switches, semaphores, stations and tunnels; couple the engine and cars; stop and start the trains and do *everything* that is done on a real railroad.

With Ives Struktiron you build strong steel models of railroad bridges, elevated railways, signal towers, cranes and derricks operated by the powerful Ives electric motor. You can also construct hundreds of other practical models, such as aeroplanes, revolving shovels, battleships.

Toy, hardware and department stores sell Ives Trains ($1 to $25), and Ives Struktiron ($2 to $30). Ask to see them.

Write for Catalog and names of Ives dealers in your town.

Poster Stamps Free

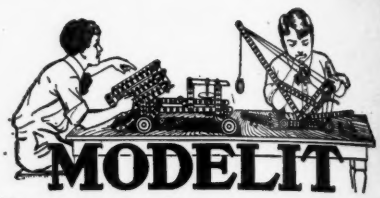
Twelve of them—beautifully illustrated in colors. Six show the development of the locomotive from the famous "De Witt Clinton" of 1831 down to 1915. The other six show remarkable Struktiron models.

Absolutely free to any boy or parent. Write now (giving toy dealer's name) for complete set.

The Ives Manufacturing Corporation

203 Holland Avenue Bridgeport, Conn.

Boys—Model It!



MODELIT

It's great sport to build "Modelit" suspension bridges, observation towers, steam rollers, trolley cars, biplanes and a hundred other things. We give you all parts and book with complete instructions. Think of the fun building a skyscraper just like the Woolworth Building! It is simple with "Modelit."

All parts making up the outfit are nickel plated steel and finished brass and every part is mechanically accurate. A high-grade Electric Motor free with most outfits.

See

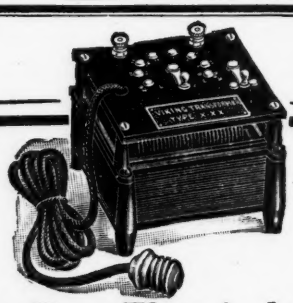
"MODELIT"

At Your Toy Dealer's

If your dealer does not carry "Modelit" send us his name and we will send you illustrated circular. It shows a great many instructive and fascinating models which can easily be made with "Modelit." Write today.

The Watrous Mfg. Company

Dept. M EAST HAMPTON, CONN.



To Run Electrical Toys; Models; Xmas Tree Illumination, Etc.

FOR every purpose requiring a low voltage, you will be surprised with the efficiency, the compactness, the mechanical perfection of design of

VIKING Toy Transformers

Write for our new BULLETIN NO. 5, which gives more valuable detailed information about toy transformers than was ever before published. Answers every question you want to ask. FREE. Send postcard TODAY.

Viking Elec. Co., 150 Chambers St., N.Y.

FREE

144 pages.
12 Chapters.
Size 3½"x5½".
Cloth Bound.
52 Pictures.
6 Page Photographs.

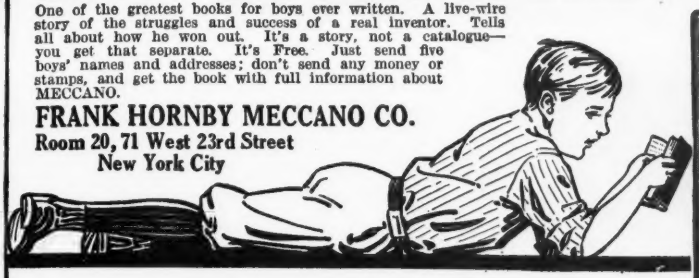
BOOK

BOYS—Get this Free Book

FREE

One of the greatest books for boys ever written. A live-wire story of the struggles and success of a real inventor. Tells all about how he won out. It's a story, not a catalogue—you get that separate. It's Free. Just send five boys' names and addresses; don't send any money or stamps, and get the book with full information about MECCANO.

FRANK HORNBY MECCANO CO.
Room 20, 71 West 23rd Street
New York City



BOYS—You Can Build All Kinds of Toys Easier, Quicker and Better With

MECCANO

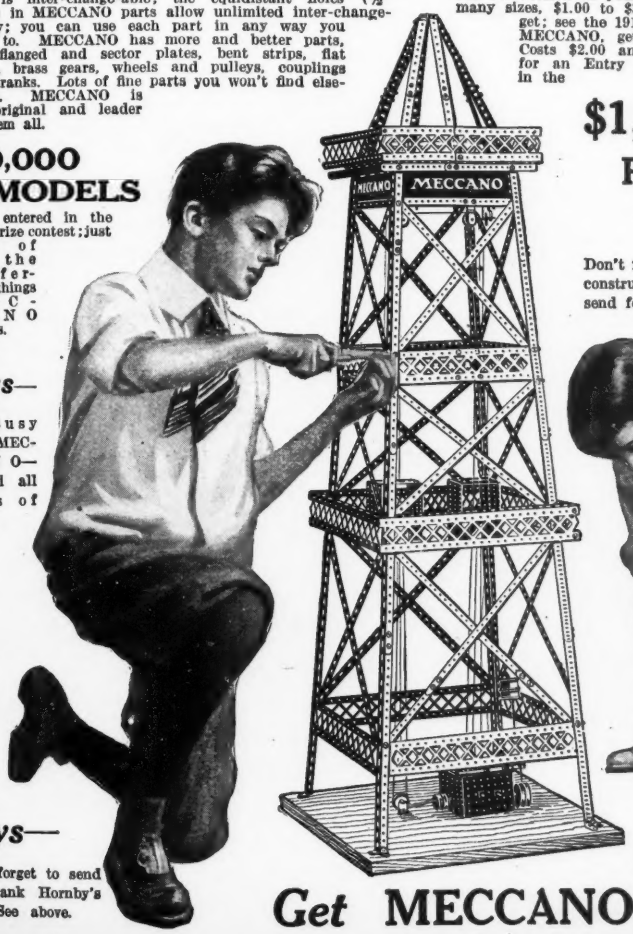
Boys, you can build any kind of a model you want to with MECCANO. Small or large, simple or complicated ones; big, sturdy toys that it's **real** fun to play with. You can have more sport; you can build mechanically correct models easier, quicker and better, because MECCANO girders are ready to use; strong and rigid. Every part is inter-change-able; the equidistant holes (½" apart) in MECCANO parts allow unlimited inter-change-ability; you can use each part in any way you want to. MECCANO has more and better parts, too; flanged and sector plates, bent strips, flat strips, brass gears, wheels and pulleys, couplings and cranks. Lots of fine parts you won't find elsewhere. MECCANO is the original and leader of them all.

10,000 MODELS

were entered in the last prize contest; just think of all the different things MECCANO makes.

Boys—

Get Busy With MECCANO—Build all kinds of models.



Boys—

Don't forget to send for Frank Hornby's book—See above.

Boys—you can get the MECCANO Electric Motor—the most powerful toy motor made—with outfits at $3.00, $5.00 and $7.50. It's a real electric engine with gear wheels and shafting; makes models run like real machines. Lifts 30 pounds; runs on dry batteries.

See MECCANO in your dealer's. Look over the outfits; many sizes, $1.00 to $36.00. See all the fine parts you get; see the 1915 improvements, too. If you have MECCANO, get the Inventor's Accessory Outfit. Costs $2.00 and contains the new parts. Ask for an Entry Blank, too, and enter a model in the

$1,000.00 Prize Contest Now On!

Don't miss MECCANO! It's the one best constructional toy. And be sure and send for the fine book offered above!

Get MECCANO!

Boys—

Be sure and see MECCANO at your Dealers.

BOYS—

Get MECCANO *for Xmas!*

BARNEY & BERRY
SKATES

Let's go skating

The Christmas Present

A Practical Gift That Is Pleasure-Giving

Barney & Berry Skates

"Used For Fifty Years Wherever Water Freezes"

Make your Christmas one of Mutual Merriment. The wearer of the famous B & B skates will experience exhilarating, healthful sport, and will glow with satisfaction that there are none better.

No other gift is so generally acceptable.

Send for our new catalog, containing hockey rules and directions for building an ice rink. It illustrates the "American Club," the "International," the "All Clamp," the "Continental," the "Tubular Hockey," the "Canadian Hockey," and others. You can select whatever style you desire and order from your dealer.

BARNEY & BERRY
139 Broad St., SPRINGFIELD, MASS.

Give your boy or girl a steering sled - *but-be sure it's a*

Flexible Flyer The only sled with non-skid runners.

Stronger, easier than ever to control.
All-steel front and chrome-nickel steel runners give added safety, durability and ease in steering. The fastest and safest sled made.

JUNIOR RACER 4 feet long. Weighs 10½ lbs. **$3.50**
Express prepaid east of Missouri River.

The Flexible Flyer comes in nine sizes—3 to 8½ feet long.

Outlasts Three Ordinary Sleds

Insist on the genuine—*it isn't a Flexible Flyer unless it bears this trade mark.*

Sold by Leading Hardware- and Dep't-Stores.

FREE. Cardboard model showing how the Flexible Flyer steers. Also attractive booklet. Write for them today!

S. L. ALLEN & CO. Box 905L Philadelphia

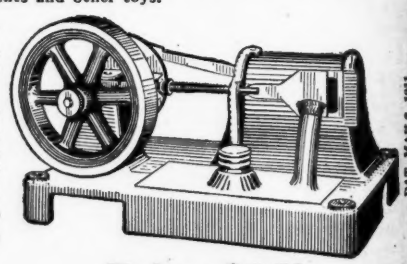
A MECHANICAL PUZZLE

SPEEDWAY VACUUM ENGINE

WHAT MAKES IT GO!
Few have been able to answer correctly.

A PERFECT TOY that "GROWN-UPS" will enjoy

A Real Engine in miniature built of high-grade steel and castings, carefully machined. Has 1-in. cylinder, 1½-in. stroke. Runs at 2000 revolutions per minute. Simple, instructive and safe. Many interesting experiments can be made with the *Speedway* running builders' outfits and other toys.



Price, $3.50

Ask your Toy dealer for the *Speedway*—if he has not got it we will send C.O.D. charges prepaid anywhere in U. S.

SPEEDWAY TOY MFG. CO.
216 Gibbons Arcade Dayton, O.

Special Electric Candlesticks

Silver-Plated, Colonial Pattern

THESE handsome Electric Candlesticks are just the thing for the Holiday season—splendid for gift purposes as well as for use in one's own home. They combine all the charming decorative value of the old-style candlestick with the safety, convenience and cleanliness of modern Electric Light. Candlesticks will be more popular than ever this year, and they must be Electric Candlesticks, to be really up-to-date.

The Pair Illustrated Above, Sent Complete, $6.80

These Electric Candlesticks stand 10-inches high, with 6- by 2¾-inch oval base. We will send the pair above illustrated, ready to use, to any address upon receipt of $6.80, shipping charges collect; completely equipped with two 60-watt natural-frosted spherical lamps, two silk shades and long silk cord (wired together, with single plug).

Price per pair, without shades. $5.00
Price of shades, each..... .90
Single candlestick, equipped as above but without shade... 2.75
Single candlestick, with shade and including one 60-watt natural - frosted, spherical lamp, cord and plug..... 3.65

(All above prices on a shipping-charges-collect basis.)

Please Use Attached Coupon When Ordering

Write name and address plainly and specify clearly which selection you make. To insure safety, remittance should be made by postal or express money order or bank draft; if currency, it should be sent by registered mail.

ELECTRIC SHOP—CHICAGO

Corner Michigan and Jackson Blvds.

Electric Shop, Michigan and Jackson Blvds, Chicago, Ill.

Enclosed find $6.80 / $3.65 / $2.75 for which please send, shipping charges collect, to the address below:

One pair Electric Candlesticks with shades ☐
One pair Electric Candlesticks no shades ☐
One Electric Candlestick with shade ☐
One Electric Candlestick no shade ☐

(Write name and address plainly in the space below)

.....

.....

Build An Aeroplane That *Flies!*

Thousands of boys, and grown-ups, too, are racing model aeroplanes that they have built themselves. It's the new scientific sport.

With an "Ideal" Construction Outfit you can easily build a perfect

3 ft. Bleriot Monoplane; outfit with all parts, ready to assemble $4.25

3 FT. WAR MODEL AEROPLANE

—a real miniature flying machine with which you can have lots of fun and intensely fascinating instruction in the great science of aeronautics.

"Ideal" Construction Outfits are made for all types of aeroplanes. They include all the necessary parts in knock-down form with simple, easily-understood building and flying directions and **exact** scale working plans.

One of our most interesting models is the

3 ft. Curtiss Military Tractor; outfit with all parts, ready to assemble $5.00

"IDEAL" TAUBE MONOPLANE

Taube.

An exact 3 ft. scale reduction of the famous German military machines playing such an important part in the EUROPEAN WAR. Outfit consists of rubber-tired disc wheels, ball-bearing propeller shaft, hand-carved wooden propeller, etc. Guaranteed to rise from the ground by its own power and fly. Delivered complete, ready to assemble, all charges paid.. **$4.25**

3 ft. Nieuport Monoplane; outfit with all parts, ready to assemble $5.00

A Present That Every Boy Wants

Scale drawings and instructions alone for all our models are offered at following prices :

CURTISS MILITARY TRACTOR	25c	Bleriot Monoplane	15c
Curtiss Flying Boat	25c	TAUBE MONOPLANE	25c
Curtiss Hydroaeroplane	35c	Wright Byplane	25c
Nieuport Monoplane	25c	Cecil Peoli Racer	25c

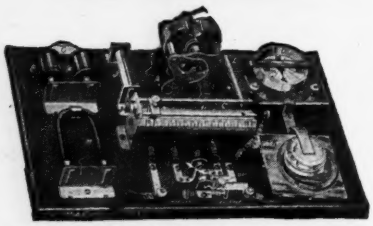
SPECIAL: Complete set of above 8 plane $1.60

There's a toy, game or department store near you at which you can get "Ideal" Model Aeroplanes and Flyers. If you can't find the store, write us.

Write today for our 50-page Aeroplane Book, containing full information as to long distance racers, prices for parts, complete models, etc., postpaid, 5c.

IDEAL AEROPLANE & SUPPLY CO., 80-86 West Broadway, New York City

Boy Electrics
KNAPP MARVELECTRIC
THE GREATEST



Every Boy should have one.

More fun, more information than a hundred books.

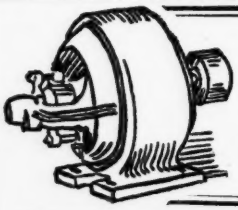
Finished as shown. Demonstrates Magnetism, Solenoids, Resistance, Motors, Dynamos.

Price $3.75

Live dealers everywhere.
Order direct, or ask your dealer to show you the Knapp Line and insist on getting Knapp Goods. Dealers not already handling the Knapp Line should ask for prices.
Catalogue illustrating many specialties on request.

Knapp Electric and Novelty Co.

517 West 51st St. N. Y. CITY



50 Light Dynamo, $60
100 " " $80

In Payments of $5 Only Per Month

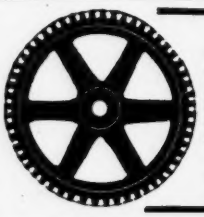
HOBART BROS. CO.
TROY, OHIO

MAKE YOUR BIKE A MOTORCYCLE

at small cost by using our Attachable outfit.

FITS ANY BICYCLE. Easily attached. No special tools required. Write today for bargain list and **FREE BOOK** describing the SHAW Bicycle Motor Attachment. Motorcycles, all makes, new and second-hand, $35 and up.

SHAW MANUFACTURING CO.
Dept. 36 Galesburg, Kansas

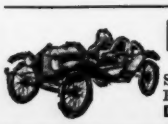


BRASS GEARS

Cut by an entirely new process. The most accurate made and at prices that cannot be equalled by others. Every gear has a hub, center painted ebony back, edges turned true, highest grade red brass, and much heavier than others. We carry the largest stock in the world, and every gear listed is always shipped on date of order.

SEND FOR CATALOGUE

CHICAGO STOCK GEAR WORKS
18 So. Fifth Ave. :: Chicago



FORD RACERS
REBUILD YOUR FORD CAR.

Sketches, Specifications and Instructions. Prepaid for twenty-five cents. **T. M. CO.**
Dept. B. Box 212, Woodfords, Maine

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Boys-Here's Fun

FREE BIG CATALOG

ASK DAD FOR THIS TRAIN

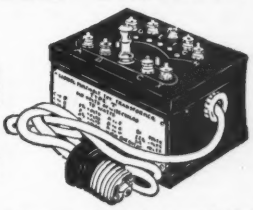
Write Quickly for Catalog

You'll have barrels of fun with a Lionel electric locomotive; couple to it Pullmans or freight cars; get switches, semaphores, electric lights, track, etc. Make the trains scoot around with a touch of your finger. Run 'em on batteries or from electricity in your house with a Lionel multivolt transformer, which saves Batteries. (See illustration.)

250,000 boys own them—join us—this quarter-million of happy boys. Lionel Electric Trains are safe—no shocks. They're steel—not Cast Iron—and won't break. Are highest grade of material throughout, but not high priced. Unconditionally guaranteed. Finished handsomely in colors and gold. Models are faithful reproductions of originals seen on our prominent railroads.

Write Quickly for New Boys' Catalog—written specially for YOU, crammed full of pictures. New photos tell you why you'll have such a dandy good time with Lionel Trains.

Section of Lionel Rail Free—Most toy dealers, electrical stores and department stores sell Lionel Toys. If you'll go to your toy dealer, find out if he sells Lionel Trains, and tell me when you write for catalog, I'll include a special section of rail—free.



If you Have Electricity surely Get this Multivolt Transformer

THE LIONEL MFG. CO.
48-J East 21st Street
NEW YORK CITY

J. LIONEL COWEN
A Friend of Boys,
President

LIONEL TOYS ELECTRIC

No More Battery Troubles
THE CAMPBELL TRANSFORMER

$2.00

Does away with all battery cost and trouble. Will ring bells—operates door openers from electric circuit. Easily installed and cannot get out of order. **Low cost plus efficiency.** Throw away those old, troublesome batteries. Try the Campbell Transformer—it's guaranteed.

Write for list of electrical specialties.

Campbell Electric Co., Lynn, Mass.

BOYS—*Get a Loop the Loop Glider*

for only 50 cents and duplicate the feats of World Famous Aviators. Will positively **LOOP THE LOOP** and perform other marvelous feats. Our GREAT MODEL AEROPLANE HANDBOOK free with each glider.

THE MODEL SUPPLY HOUSE, W.H.Phipps, Dept.L, 503 Fifth Ave., N.Y.City

ELECTRICITY
IDEAL XMAS GIFTS

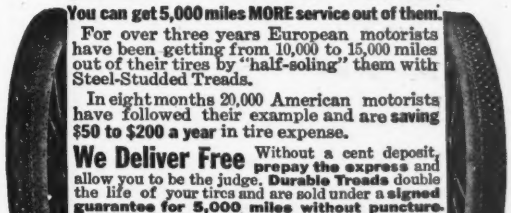
BOYS—This book is a mine of electrical knowledge, 128 pages full of cuts, complete description and prices of the latest **electrical apparatus** for experimental and practical work—Motors, Dynamos, Rheostats, Transformers, Induction Coils, Batteries, Bells, Telephone Sets, Telegraph Outfits. Greatest line of miniature **Electric Railways** and parts. Toys and Novelties. This catalog with valuable coupon sent only for 6c in stamps. (No postals answered.)

VOLTAMP ELECTRIC MFG. CO.
Park Building Baltimore, Md.

SONG POEMS WANTED

Send us your verses or melodies today. Experience unnecessary. Acceptance for publication guaranteed if available. Write for free valuable booklet. **MARKS-GOLDSMITH CO.**, Dept.92, Washington, D. C.

Don't Throw Away Your Worn Tires



You can get 5,000 miles MORE service out of them.

For over three years European motorists have been getting from 10,000 to 15,000 miles out of their tires by "half-soling" them with Steel-Studded Treads.

In eight months 20,000 American motorists have followed their example and are **saving $50 to $200 a year** in tire expense.

We Deliver Free Without a cent deposit, **prepay the express** and allow you to be the judge. **Durable Treads** double the life of your tires and are sold under a **signed guarantee for 5,000 miles without puncture.** Applied in your own garage in thirty minutes.

Special Discount offered to motorists in new territory on first shipment **direct from factory.** Don't take any more chances with your tires. Mail the coupon **today** and find out how to get 5,000 more miles out of them.

—Tear off and Mail—Save the Discount—

Colorado Tire & Leather Company
1249 Tread Bldg., Denver, Col. L49 Transportation Bldg., Chicago.
4912 Woolworth Bldg., New York.

Gentlemen:- Please send me without obligation, sample, copy of 5,000 mile guarantee, special discount terms and book "10,000 Miles on One Set of Tires".

Name _____

Address _____

_____

My Tire Sizes are _____

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ENGINE POWER

Costs Less Now

Besides our lower prices, WITTE engines use less fuel, and cost less for up-keep—enough saving, in a year to pay entire engine price.

WITTE Engines

Gasoline, Kerosene, Distillate, Gas.

2 H-P $34.95; 4 H-P $69.75; 6 H-P $97.75
8 H-P $139.65; 12 H-P $197.00; 16 H-P $279.70
22 H-P $359.80. Portable Engines Proportionally Low.
F. O. B. Factory. Cash or Easy Terms.

Sent Direct From Factory Under 5-Year Guarantee

Before you buy any engine, for any kind of a price, let us tell you where, and how, to look for engine quality—the things that make lower-cost power with easy starting, (no cranking) steady running and utmost durability.

New Book Free Tells plainly **how to judge engines** easily. Write us for it today.

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2225 Oakland Avenue, Kansas City, Mo.
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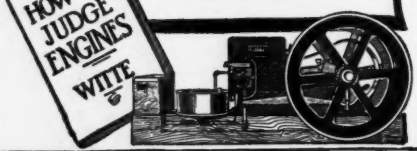

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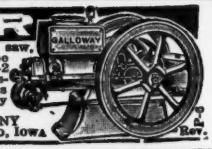
POWER for farm, ranch, shop, to pump, saw, excavate, hoist, irrigate, can be had in Galloway engines from 1 1-2 to 16 h. p. All styles. 200,000 customers testify to quality. Prices from 1-3 to 1-2 what's usually asked. Low freight.



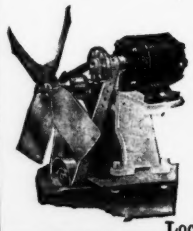
WM. GALLOWAY COMPANY
Box 2095 WATERLOO, IOWA Rev.

No. 68 Carleton Generator

7 Volts 7 Amperes (49 C. P.)

solves the lighting problem.

Steady light with or without storage batteries



Special brackets for Ford, Saxon and Metz cars, but easily applicable to any car, cycle, boat or miniature stationary plant. Highest quality construction and moderate price; not to be confounded with cheap, permanent magnet generators. Also Automatic Cut-outs, Storage Batteries, Governors and Ammeters. Descriptive Bulletin explains.

SPECIAL 12-Volt, 10-Ampere Generators for boats or stationary work. Local demonstrating agents wanted where there are no dealers.

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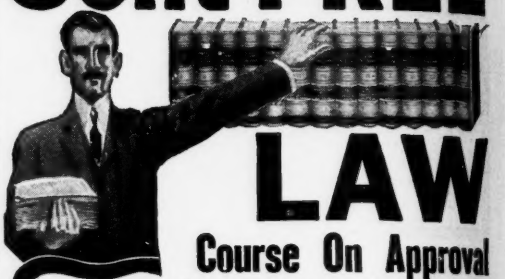

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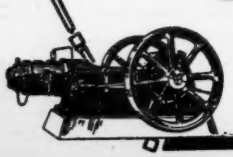

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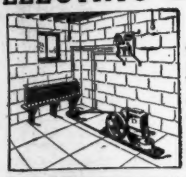

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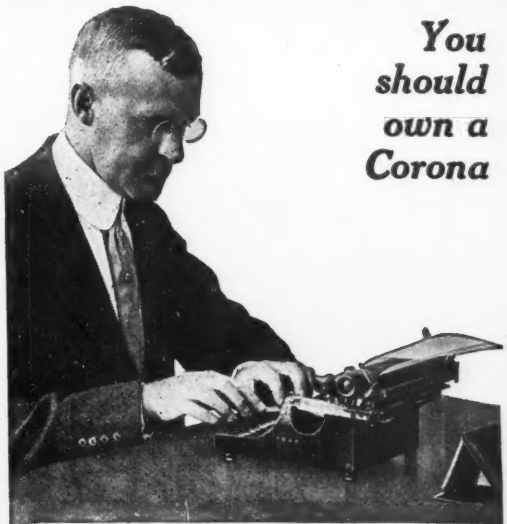

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Your letter, personal or business, should be neat looking and legibly written to make as good an impression as you would like to make personally.

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At home, in the office, or when you travel you will find it a great aid in conducting your correspondence, writing reports or manuscripts.

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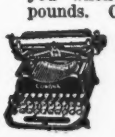

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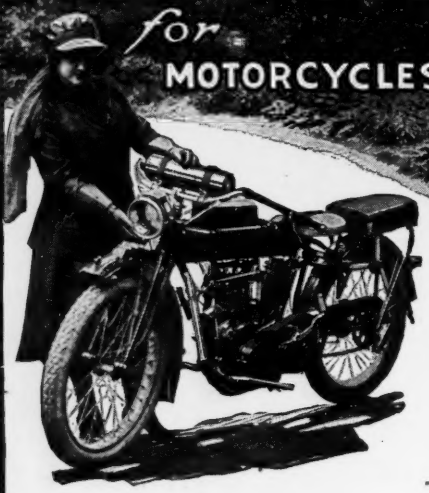

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Prest-O-Lite gives perfect riding light—is as sturdy as your motorcycle itself. It stands the jolts, needs no attention you yourself cannot give. Practical, simple, and trouble-proof.

Considering its simplicity and freedom from trouble, it is at once the most convenient and the most economical lighting system for motorcycles.

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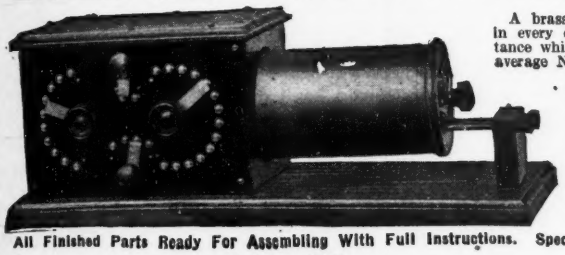
Bargain Prices to prove the wonderful values and superior goods we give you direct from our factory. These ridiculously low prices are only made possible by our enormous output for our tremendous trade. All highest quality, beautifully made and thoroughly tested out.

Save 25% If You Act Quickly

Here is Your Opportunity to Secure the Best Navy Type Loose Coupler on the Market. Regular Price, $15.00. For December Only—Reduced Sale Price $10.00



A brass lacquered 6,000 meter inductance tuner, perfect in every detail. Equipped with four point loading inductance which increases the wave length 4,000 meters over the average Navy Type Transformers. The primary winding has 24 taps—one switch controls the primary in groups of tens, the other controls one turn at a time—and is equipped with a dead end switch. Enclosed in a cabinet, the front of which is polished hard rubber. The secondary coil is wound with double silk covered wire and the inductance is varied by a ten point switch. With this coupler the very finest and most accurate tuning is easily and quickly secured. With a good sized aerial the reception of wave lengths up to 6,000 meters is possible.

All Finished Parts Ready For Assembling With Full Instructions. Special..... $6.50

A Thoroughly Reliable Station

Our No. 810 Complete

Sending and Receiving Station

Regular Price, $20.00
For December, Sale Price Only $14.00

Sends up to 12 miles. Receives up to 1,000 miles.

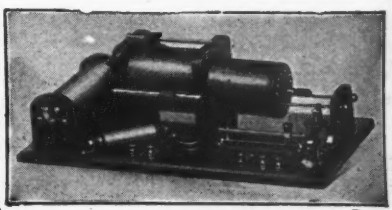
Full 1½ inch coil type. Sends up to 12 miles. Receives up to 1,000 miles under favorable conditions. Equipped with 2 double pole 1,000 ohm receivers, 6 feet silk cord and double headband. Size of base 12 x 16 inches, height 13 inches, weight only 14 pounds.

This is a completely equipped and thoroughly reliable station, mechanically and electrically perfect and ready for instant service. Nothing better in this class was ever constructed. The new improved tuning coil enables you to tune in or tune out any party you might desire, thus eliminating any interference. The set consists of a 1½ in. Spark Coil, 12 Flat Plate Condensers, our "Don't Jar Out" Detector, Buzzer and Switch to tell if your detector is working. Double Slide Silk Wire Wound Tuner for long wave station capacity, Fixed Condenser, Helix, Key, DPDT Switch and complete 2,000 Ohm Headset.

Receive the Time From Arlington AND ALL NEWSPAPER AND SHIP REPORTS

Our Special Time Signal Receiving Outfit - - - $8.10

Regular Price, $10.85

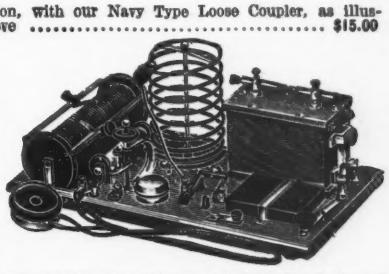


This is our new 1915 model made of the highest grade material obtainable. Double slide coupler for close tuning is wound with No. 24 green silk covered wire on the primary—the secondary with No. 28. There are 8 points to divide its capacity. A 3,000-metre loading coil placed between the coupler and the aerial by a switch that throws it in or out of the circuit enables you to receive amateurs with the coupler alone and long wave stations by the addition of the loading coil. One fixed condenser of proper capacity, improved universal detector, one buzzer test to test your mineral and potentiometer. This instrument is assembled on a highly finished oak base. All metal parts are heavy nickel-plated.

This station, with our Navy Type Loose Coupler, as illustrated above $15.00

Our No. 401 Sending and Receiving Station

Regular Price, $5.95
For December Only, Sale Price $4.95



Consists of ¼-inch coil, fluted end spark gaps, four plate secondary, one collapsible helix, one key, a two-slide tuner, fixed condenser, detector and buzzer test to test your mineral. This set is mounted on a highly finished oak base with all metal parts heavy nickel-plated. With a good-sized aerial, under favorable conditions, will send up to 3 miles and receive up to 300 miles.

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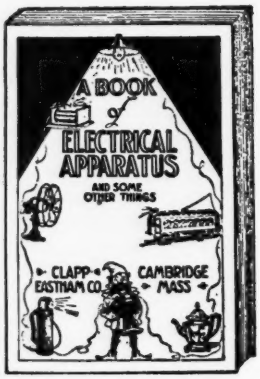

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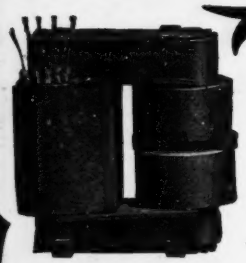

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This is the Transformer you need to get the result you want

It is a ½ K.W., and is built on the same specifications as to materials, workmanship, etc., as our big Central Station transformers.

Hundreds of stations are now using these transformers. This transformer gives you

13200 VOLTS

Let us tell you how you can do part of the work yourself and get this excellent transformer at a remarkably low cost.

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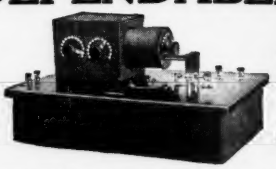
PRICE as shown $20.00



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This is one of our new Receiving Outfits

In it we have combined
Our L 102 Inductive Tuner
Our 110 Silicon Detector
Our 1220 Fixed Condenser
And our special 43 Plate Variable Condenser

All the instruments are finished in nickel and Electrose ends are used on the tuner. The Cabinet is made of mahogany finished wood, hand rubbed. There are name plates for the connections of the Aerial, Ground and Receivers. We do not furnish the Phones because of the difference of opinion of the Experimenters.

This outfit will receive Time Signals from Arlington and Key West, with an aerial 60 feet long and 50 feet high, over a distance of 1,500 miles.

The Cabinet is 16 inches long, 12 inches wide, and 4 inches deep. It is the best outfit that can be had for less than $50 and for sensitiveness it has no equal.

We recommend Brandes receivers for this outfit

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These are *Real Wireless* Receivers

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Send for a pair today and *try them out* against any other make you know of. Try them for long and short distance messages. If you do not find them better—yes, better in every way, in sensitiveness, tone, weight—than any receiver you have ever used, we'll gladly refund your money.

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Complete with Headband—$5

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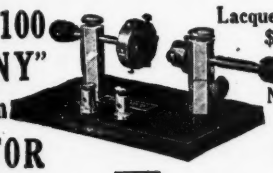
BRANDES WIRELESS HEAD SETS

The No. 100 "ALBANY" Combination DETECTOR



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Polished Nickel $2.50
Weight 1 Pound

December 15th is the last day on which you will be able to purchase a No. 102 "ALBANY" Rotary Condenser for $2.50. Thereafter the price will be $3.25, as formerly.

MAGUIRE & SHOTTON
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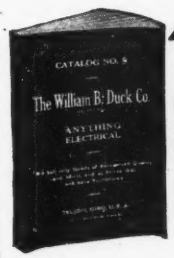

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40 more pages of wireless instruments at more attractive prices than ever.

Also many new items in electrical supplies at substantial reductions in price.

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Great cost of catalog and low prices prohibit distribution otherwise

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5 pp. Transformers;	25 pp. Electrical and Mechanical Books;
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15 pp. Telegraph Insts.;	10 pp. Auto Accessories;
42 pp. Motors and Dynamos;	13 pp. Victrolas, on our Easy Payment Purchase Plan (No Down Payment);
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8 pp. Flashlights;	
5 pp. Massage Vibrators;	
10 pp. Miniature Railways;	

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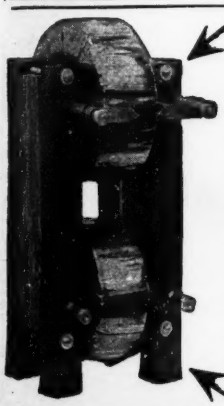
224-228 Superior Street, Toledo, Ohio



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¼ K.W..... $ 8.00
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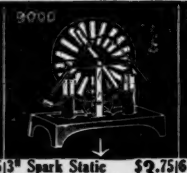
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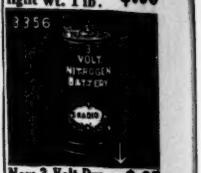
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Again he writes: "Yours of the 28th at hand. I use a Triple Valve Station of highest class and thought I had the best on the market, but when I hooked your Multi-Audi-Fone to the third Audion I was astonished at its Amplification.

"I laid your Phones on the table and walked one hundred and twenty-five feet to the rear of my store and copied Arlington and Key West at 9:30 P.M. Many 600 Meter stations I also copied at this same distance. I also hooked your Multi-Audi-Fone to a single Audion and signals were much louder than all three of my Amplifiers."

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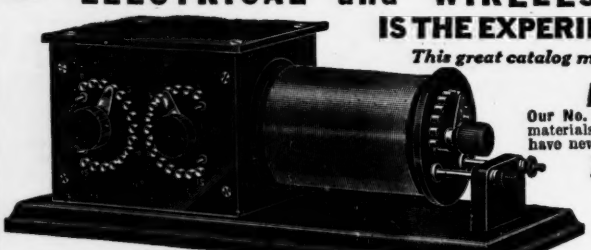

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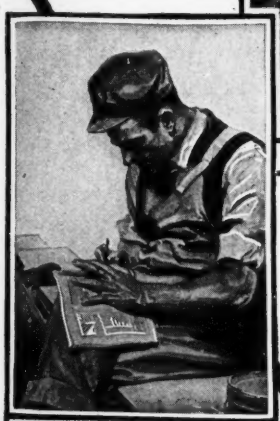

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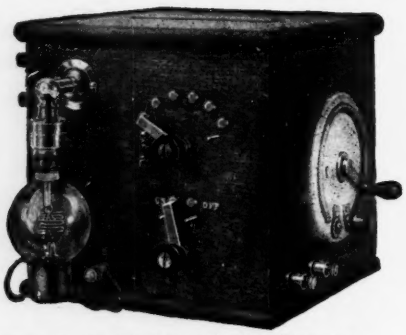

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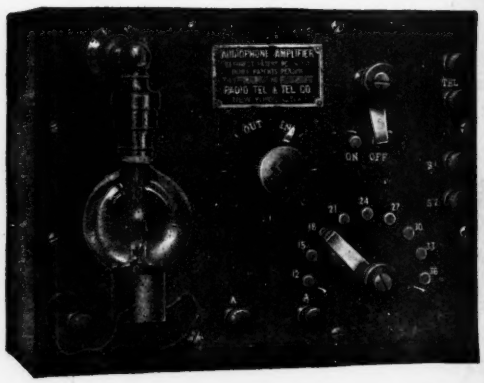

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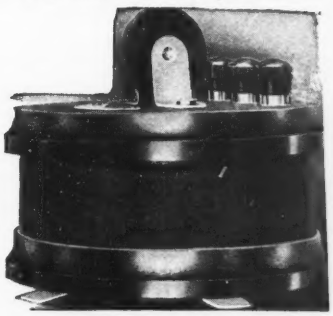

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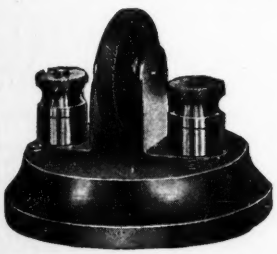

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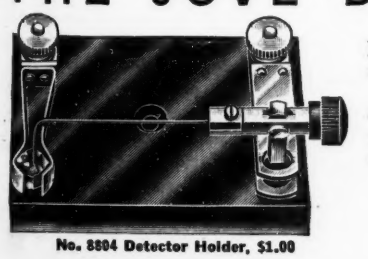

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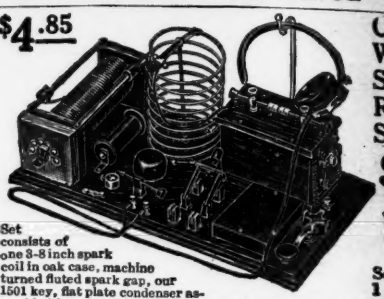

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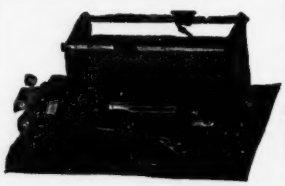

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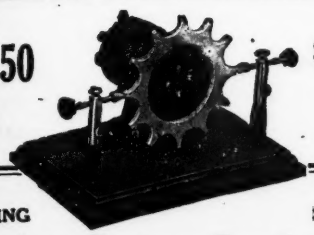

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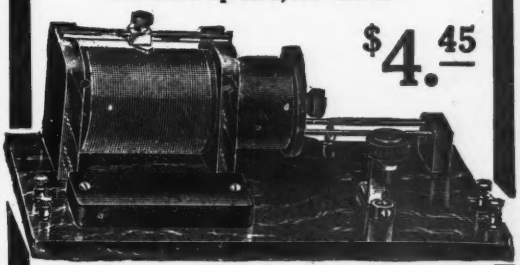

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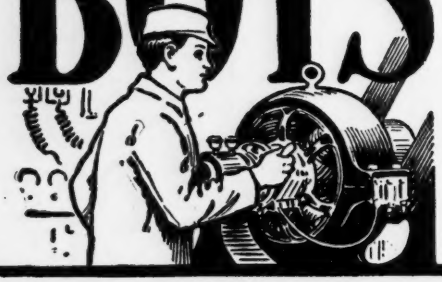

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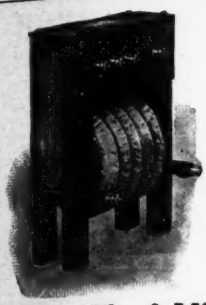

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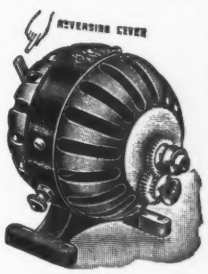

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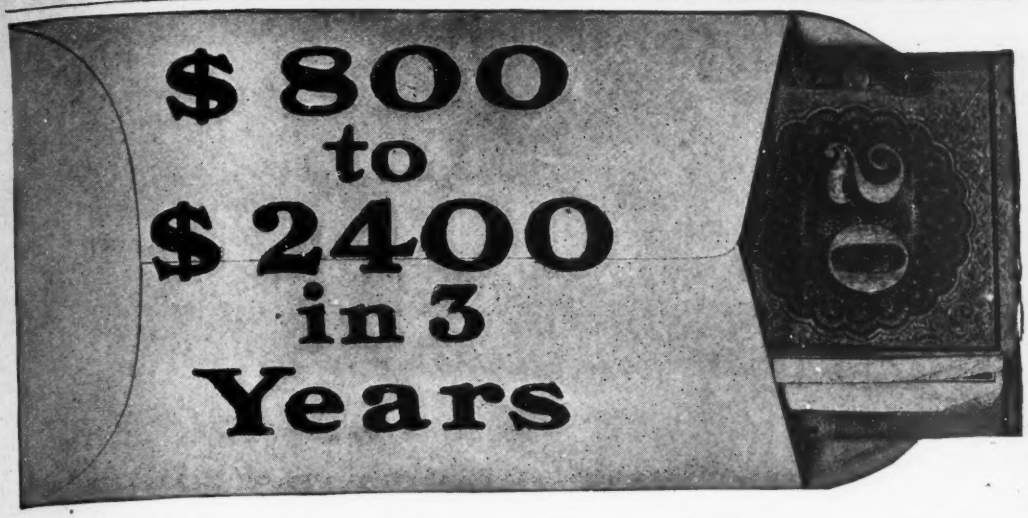

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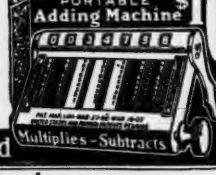

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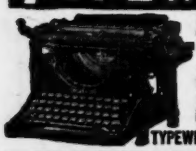

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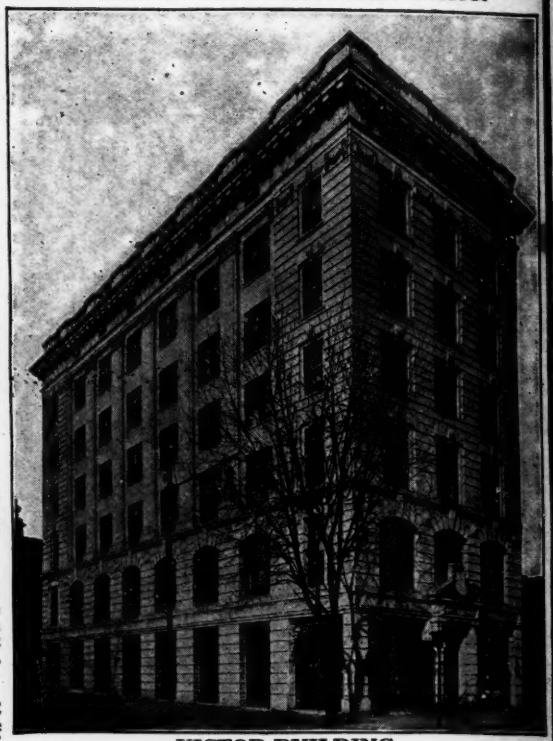

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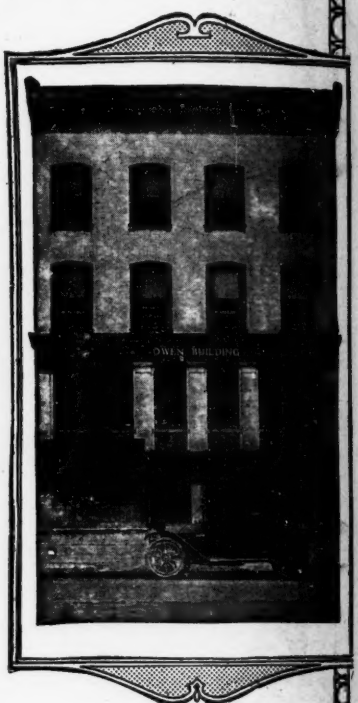

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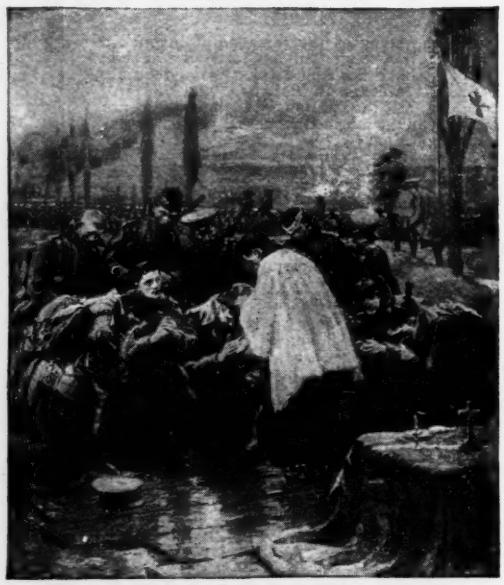

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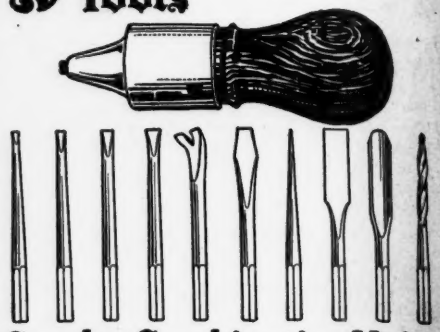

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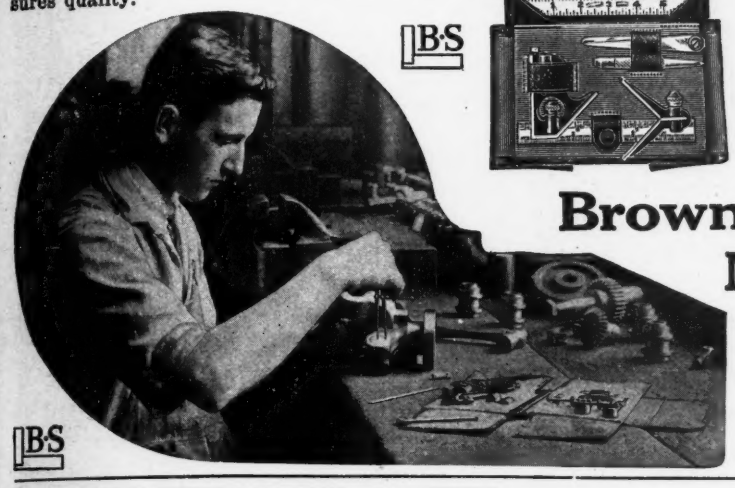

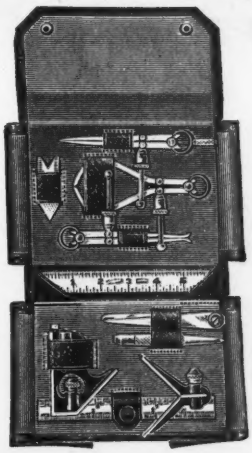

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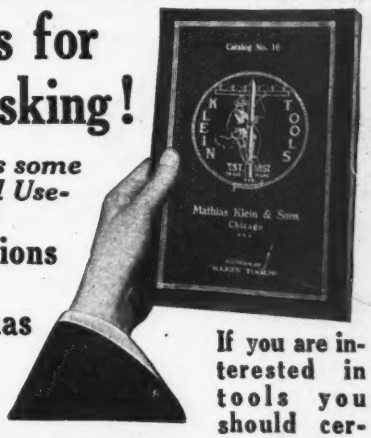

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